

**ODONTOLOGIC STUDIES
OF
MIDDLE-AGED URBAN WOMEN**

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APPENDIX

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Malmö 1987

- I Ahlqwist M, Halling A & Hollender L. Rotational panoramic radiography in epidemiological studies of dental health.
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- II Halling A & Bengtsson C. Dental status of Swedish middle-aged women as found in a population study in Göteborg, Sweden. *Swed Dent J* 1981.5.1-7.
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- IV Halling A & Björn A-L. Periodontal status in relation to age of dentate middle-aged women. A 12 year longitudinal and a cross-sectional study. *Swed Dent J* 1986 (accepted).
- V Halling A & Björn A-L. Periodontal status in relation to education and dental attendance. A 12 year longitudinal and a cross-sectional study of a random sample of dentate middle-aged women.
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- VI Björn A-L & Halling A. Periodontal bone height in relation to number and type of teeth in dentate middle-aged women.
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- VII Hällström T & Halling A. Prevalence of dentistry phobia and its relation to missing teeth, alveolar bone loss and dental care habits in an urban community sample. *Acta psychiatr scand* 1984.70.438-446.



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Paper I

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Paper 1

Rotational panoramic radiography in epidemiological studies of dental health

Comparison between panoramic radiographs and intraoral full mouth surveys

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Key words: Panoramic radiography, epidemiology, dental health

ABSTRACT

In conjunction with an epidemiological study of oral health in women the capacity of the panoramic radiograph to yield information on oral conditions was compared to that of the intraoral full mouth survey including posterior bitewing radiographs.

Full mouth surveys and panoramic radiographs of 75 women were compared for gross characteristics such as distribution of teeth, missing teeth, restorations, and endodontic treatment as well as for osteolytic lesions at the root, marginal bone loss and carious lesions.

A nearly 100% agreement was found for gross characteristics but also for osteolytic lesions associated with teeth and for marginal bone loss the agreement was good; osteolytic lesions at single rooted teeth 76%, multirooted teeth 90% and a coefficient of correlation of .96 for individual mean marginal bone scores. Poor agreement was found for carious lesions as only 36% of those extending well into the dentine were found both in the intraoral radiographs and in the panoramic radiographs.

It may be included that, except for carious lesions, the panoramic radiographs can be considered a useful tool in epidemiological studies of oral health.

SAMMANFATTNING

I samband med en epidemiologisk studie över tandhälsan hos kvinnor gjordes en jämförande studie mellan helstatus inklusive bitewingsbilder och panoramaröntgen på 75 kvinnor. De variabler som användes var dels grövre karakteristika såsom fördelning av tänder, saknade tänder, restaurationer och endodontiskt behandlade tänder, dels variabler såsom destruktion vid rötterna, marginal benförlust och kariesskador.

Överensstämmelsen blev nära 100% för de grövre karakteristika. För destruktioner vid flerrotiga tänder var överensstämmelsen 90%, för enrotiga 76%. Även för den individuella marginala benscoren var överensstämmelsen god (korrelations-koefficienten = 0.96 medan den var påtagligt sämre (36%) för kariesskador i dentinet och närmast obefintlig för kariesskador i emaljen (7%)).

För de flesta variabler använda i studier av tandhälsa var överensstämmelsen så god att panoramaröntgenbilden får anses vara ett värdefullt instrument i epidemiologiska studier.

INTRODUCTION

The panoramic radiograph (Panoramic radiograph is in this paper used for rotational panoramic radiograph) allows imaging of the upper and lower jaw including the condylar processes and the maxillary sinuses in one single film. It is used both as a complement to the full mouth survey (FMS) and separately and is today a common adjunct in oral radiographic diagnosis. Its usefulness in epidemiological studies has been demonstrated by *Björn & Holmberg* (1966), *Morris et al.* (1969), *Keith* (1972), and *Hansen & Johansen* (1976).

Studies comparing the number of periapical osteolytic lesions diagnosed in FMS with that found in panoramic radiographs yield contradictory results. *Gröndahl et al.* (1970) concluded that the number of periapical lesions detected with panoramic radiography was only 50% of that detected with FMS, whereas *Ohba & Katayama* (1972) found more periapical lesions in panoramic radiographs than in FMS. *Balis* (1981), in this respect, reported a sensitivity for the panoramic radiograph of 79% and *Muhammed & Manson-Hing* (1982) found no significant differences between the two methods. Because of the anatomy of the jaws and the varying thickness of the sharp layer the percentage of periapical lesions found in panoramic radiographs will vary in different regions of the jaws. Thus the percentage of periapical lesions found in the anterior regions was lower than that, found in the posterior regions (*Gröndahl et al.* 1970, *Horton et al.* 1977, *Stephens et al.* 1977), indeed *Horton et al.* found more lesions in the posterior regions in panoramic radiographs than in FMS.

Westerholm & Uotila (1965), comparing panoramic radiographs and clinical registration, found the same degree of marginal bone loss. *Ainamo & Tammisalo* (1967) showed that panoramic radiographs yielded more reliable information on the degree of marginal bone loss than FMS. However, *Gröndahl et al.* (1971) concluded that pano-

ramic radiographs appeared to underestimate minor marginal bone loss whereas they seemed to overestimate extensive bone loss; the two methods agreeing in about 50% of the surface. A higher bone loss score in panoramic radiographs than in FMS was found by *Muhammed & Manson-Hing* (1982). *Balis* (1981) stated that the panoramic radiograph was totally useless in the diagnosis of periodontal disease in children explained by the fact that periodontitis in a young population is limited to milder forms of the disease. When diagnosing the marginal bone level in panoramic radiographs, the number of measurable surfaces is smaller than when using FMS (*Björn & Holmberg* 1966, *Mutschelknauss & von der Ohe* 1978, *Adrianes et al.* 1982).

The shortcomings of panoramic radiographs in detecting carious lesions in the front teeth have been noted by *Stewart & Bieser* (1968), *Ohba & Katayama* (1972), *Stephens et al.* (1977) and *Muhammed & Manson-Hing* (1982). *Hurlburt & Wuehrmann* (1976) and *Balis* (1981) stated that small carious lesions were often not detected in a panoramic radiograph while larger lesions were easier to detect.

With respect to other findings such as supernumerary teeth retained teeth, aplasia, the agreement between the two methods appears to be good (*Stewart & Bieser* 1968, *Stephens* 1977 and *Balis* 1981).

Although there is a general agreement that panoramic radiographs are inferior to FMS in detecting pathological conditions in the anterior regions, opinions still vary widely on the overall efficiency of panoramic radiography in detecting periapical lesions and marginal bone loss. These variations in opinion may partly be explained by differences in number and type of patients, number and quality of the periapical intraoral radiographs, different intraoral techniques employed (bisecting technique or paralleling technique), possible addition of bitewing radiographs, and, perhaps not least, by different types of panoramic apparatuses and techniques used. Differences in criteria for various pathological con-

ditions may also play a significant role and perhaps more so different cut-off points used by different observers.

At present, a comprehensive population study of 1,200 women, 38–72 years of age, is in progress in Göteborg. Oral health is evaluated by means of panoramic radiographs. In order to elucidate the capacity of the panoramic radiograph to yield information on number of teeth, restorations, endodontically treated teeth, periapical lesions, marginal bone level, carious lesions and other findings, a study was undertaken to compare the findings in panoramic radiographs with those in intraoral full mouth surveys including four posterior bitewings.

Since in all probability the FMS obtained with paralleling technique are more reliable in revealing these conditions, the diagnoses made in FMS were used as a reference for the findings in panoramic radiographs.

MATERIAL AND METHODS

Panoramic radiographs and full mouth surveys (FMS) of 75 women were obtained from the archives at the Department of Oral Radiology, University of Göteborg, Sweden.

The FMS, consisting of 16 periapical films supplemented by four bitewing radiographs, were taken with the films placed as parallel as possible to the long axes of the teeth. Each woman had been examined with both a panoramic radiograph and FMS at the same visit. The selection of patients was made randomly from age groups matching those of the above mentioned population study in order to obtain patients with the same type and frequency of pathological conditions (Table 1). The items studied are shown in Table 2. Registration of the different parameters were performed by the authors (MA and AH) as shown in Table 2. Osteolytic lesions were registered by the authors MA and LH simultaneously.

The marginal bone loss was assessed by using a five-graded transparent ruler (*Björn & Holmberg 1966*). Using this method, the whole crown of the tooth, the marginal bone level, and the apex of the root have to be identified. Except for "impacted teeth" the 28-teeth dentition was considered when judging teeth and tooth related conditions.

The panoramic radiograph of each patient was examined at least one month before the FMS of the same patient in order to minimize the possibility of remembering the findings of the first examination while making the second. All films were examined with a viewer according to *Mattsson (1953)*.

RESULTS

GROSS CHARACTERISTICS AND FILLINGS

The distribution of the teeth of the 75 patients is given in Figure 1. In Table 3, the numbers of missing, restored, non-restored teeth and endodontically treated teeth are given for the two methods. Generally, there was good agreement between the two techniques. The largest differences were found for anterior restorations (Table 4).

There was full agreement between the two authors (MA, AH) regarding the gross characterization of the teeth both for FMS and panoramic radiographs.

Table 1. The 75 women examined radiographically 1980/81 distributed by year of birth.

Year of birth	Number
1908	11
1914	18
1918	9
1922	7
1930	12
1942	18
Total	75

Table 2. Items registered in the study comparing radiological findings in FMS and panoramic radiographs. Registrators within brackets.

Variables	Definition/comments
GROSS CHARACTERIZATION OF THE TEETH (MA+AH)	
1. Missing teeth	Not visible teeth
2. Teeth without restorations	Retained roots excluded
3. Teeth with restorations	Teeth with fillings or crowns
4. Retained roots	a. marginally not covered by bone b. marginally covered by bone
5. Impacted teeth	
RESTORATIONS (AH)	Metallic/radiolucent
CROWNS (AH)	a. without visible posts b. with visible posts
BRIDGES (AH)	a. abutment teeth b. pontics
ENDODONTICALLY TREATED TEETH (MA)	Including amputation
OSTEOLYTIC LESIONS AT THE ROOT (MA+LH)	a. widened periodontal ligament space b. osteolytic lesion
MARGINAL BONE LEVEL (AH)	Index units 0-4 (Björn & Holmberg 1966)
FURCATION INVOLVEMENT (AH)	
CARIOUS LESIONS (AH)	Primary and secondary carious lesions a. enamel b. dentinal c. gross caries
OTHER FINDINGS (MA)	
1. Pathology in connection with impacted teeth	Widened follicles , resorptions of tooth substance
2. Mucosal thickening of the maxillary sinus	
3. Isolated osteolytic or sclerotic areas not related to teeth	
4. Foreign bodies, supernumerary teeth etc	

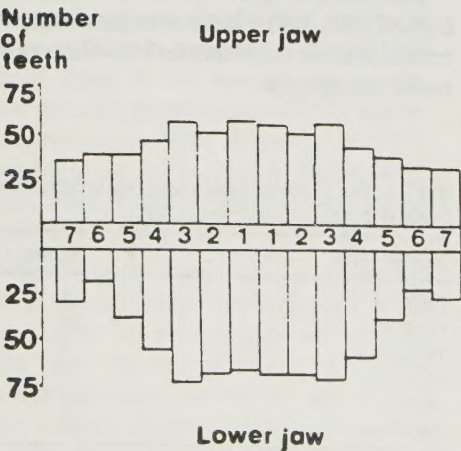


Fig. 1. Distribution of remaining teeth in the jaws.

Table 3. Radiological findings in FMS and panoramic radiographs (PAN). If not otherwise stated third molars are excluded.

	FMS	PAN
MISSING TEETH	766	768
TEETH WITHOUT RESTORATIONS	333	360
TEETH WITH RESTORATIONS	983	953
RETAINED ROOTS		
Not marginally covered by bone	11	11
Marginally covered by bone	7	8
IMPACTED TEETH (including third molars)	8	8
METALLIC RESTORATIONS		
Proximal	617	608
Occlusal	353	350
RADIOLUCENT RESTORATIONS		
Proximal	330	247
CROWNS		
Without posts	125	131
With posts	179	176
BRIDGES		
Abutment teeth	162	164
Pontics	98	98
ENDODONTICALLY TREATED TEETH		
One root	196	192
Mes/mesbucc root	60	57
Dist/distobucc root	58	57
Palatal root	18	18

Table 4. Regional distribution of teeth with or without restorations.

Anterior; from cuspid to cuspid.

Posterior; premolars and molars.

	FMS	PAN
TEETH WITH RESTORATIONS		
Posterior, upper	288	288
Anterior, upper	290	280
Posterior, lower	233	231
Anterior, lower	172	154
TEETH WITHOUT RESTORATIONS		
Posterior, upper	17	17
Anterior, upper	40	51
Posterior, lower	38	38
Anterior, lower	238	254

OSTEOLYTIC LESIONS AT THE ROOT

In Table 5 the results for single- and multi-rooted teeth are given, including (Table 5 A) and excluding widened periodontal ligament spaces (Table 5 B). The agreement was calculated from the formula

$$\frac{\text{FMS}^+\text{PAN}^+}{(\text{FMS}^+\text{PAN}^+ + \text{FMS}^+\text{PAN}^- + \text{FMS}^-\text{PAN}^+)} \times 100\%$$

(for explanation of symbols see Figure legend). When Widened periodontal ligament spaces were included for single-rooted teeth there was 72% agreement and when excluded 76% agreement between the methods. For multi-rooted teeth over 90% agreement was found between panoramic radiograph and FMS techniques both when widened

periodontal ligament spaces were included or excluded.

If the number of osteolytic lesions at the root found in the FMS is considered the true value, an estimation of the sensitivity (TP %) of panoramic radiography in this respect may be made. For single-rooted teeth the sensitivity was 86% when widened periodontal ligament spaces were included and 82% when they were excluded. For multi-rooted teeth the corresponding sensitivity values were 96% and 94% respectively. The number of over-diagnoses was small when widened periodontal ligament spaces were excluded (for single-rooted teeth six and for multi-rooted teeth one) indicating a high specificity. When widened periodontal ligament spaces were

Table 5. Number of osteolytic lesions, distributed on single-rooted teeth, multi-rooted teeth (mesial or distal root) and palatal root, as found in FMS and panoramic radiographs (PAN)

A. Including widened periodontal ligament space

Region	FMS ⁺ PAN ⁺			FMS ⁺ PAN ⁻			FMS ⁻ PAN ⁺		
	Single-rooted	Multi-rooted	Pal root	Single-rooted	Multi-rooted	Pal root	Single-rooted	Multi-rooted	Pal root
Posterior, upper	17	26	11	5	2	1	3	0	0
Anterior, upper	38			9			8		
Posterior, lower	21	16		1	0		5	0	
Anterior, lower	24			1			6		
Total	100	42	11	16	2	1	22	0	0

B. Excluding widened periodontal ligament space

Region	FMS ⁺ PAN ⁺			FMS ⁺ PAN ⁻			FMS ⁻ PAN ⁺		
	Single-rooted	Multi-rooted	Pal root	Single-rooted	Multi-rooted	Pal root	Single-rooted	Multi-rooted	Pal root
Posterior, upper	15	20	9	2	2	1	1	0	0
Anterior, upper	24			9			3		
Posterior, lower	15	12		1	0		0	1	
Anterior, lower	13			3			2		
Total	67	32	9	15	2	1	6	1	0

FMS⁺PAN⁺ = Findings made with both techniques.

FMS⁺PAN⁻ = Findings made only with FMS.

FMS⁻PAN⁺ = Findings made only with PAN.

Posterior = premolar, molar regions.

Anterior = from cuspid to cuspid.

included the number of overdiagnoses was 22 for single-rooted teeth; for multi-rooted teeth there were no overdiagnoses.

MARGINAL BONE LOSS

The distributions of nonmeasurable tooth surfaces for both FMS and panoramic radiographs are shown in Figure 2 a, 2 b. The measurability in different regions is shown in Table 6. The highest value for panoramic radiographs was found in the lower premolar and molar regions (88%).

Table 6. Measurability of bone heights for FMS and panoramic radiographs (PAN) (in per cent). Comparison between different regions in the dentition.

Region	Total number of surfaces	Measurability %	
		FMS	PAN
17 ... 14	310	85.8	59.4
13 ... 23	660	85.6	57.7
24 ... 27	300	90.7	54.3
47 ... 44	272	87.9	87.5
43 ... 33	818	93.9	68.2
34 ... 37	272	90.4	90.4
Third molars	54	70.4	59.3

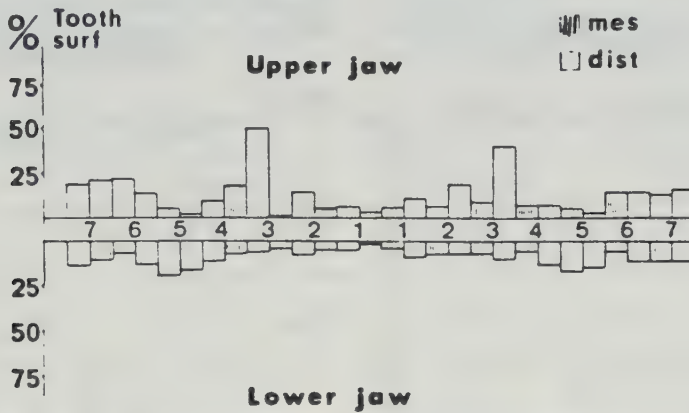


Fig. 2a. The percentual distribution of non-measurable tooth-surfaces in bone score measurements in full mouth surveys (FMS).

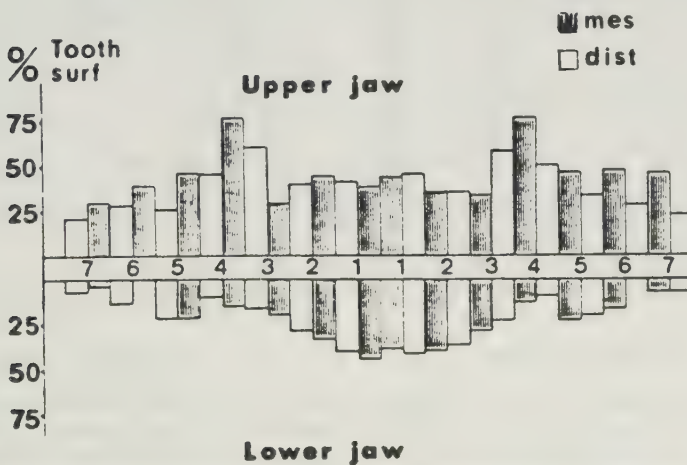


Fig. 2b. The percentual distribution of non-measurable tooth-surfaces in bone score measurements in panoramic radiographs (PAN).

The distribution of bone score units for anterior and posterior teeth is shown in Figure 3 a and 3 b.

In figure 4 the mean individual bone scores for the two methods are plotted against each other. The correlation coefficient was 0.96.

FURCATION INVOLVMENT

In Table 7 the number of furcation involvements at molars and premolars observed in

FMS and panoramic radiographs respectively are shown. Widened ligament spaces excluded, the agreement was 62%. The sensitivity value was 80%. The number of overdiagnoses was 18 indicating a specificity of more than 90%.

CARIOUS LESIONS

In Table 8 The results are given for proximal carious lesions of different extent.

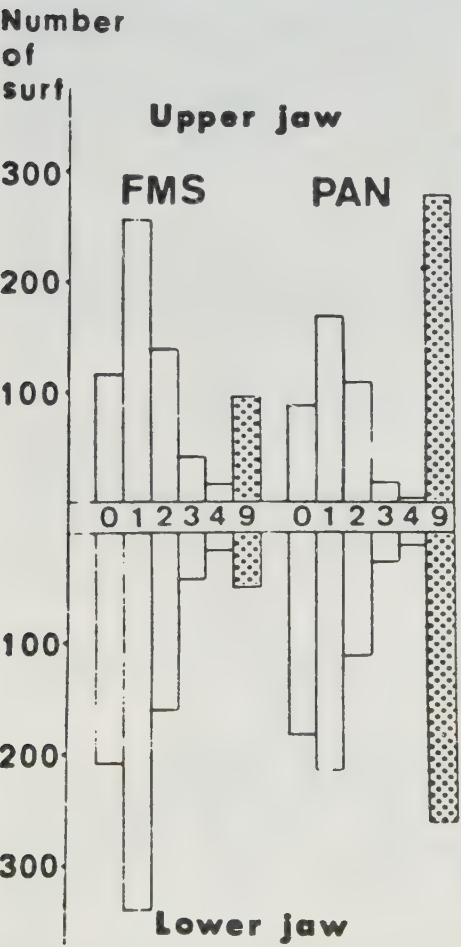


Fig. 3a. The distribution of different bone score units (value 0-4) on mesial and distal surfaces for the anterior regions in full mouth surveys (FMS) and panoramic radiographs (PAN). 9 = non-measurable.

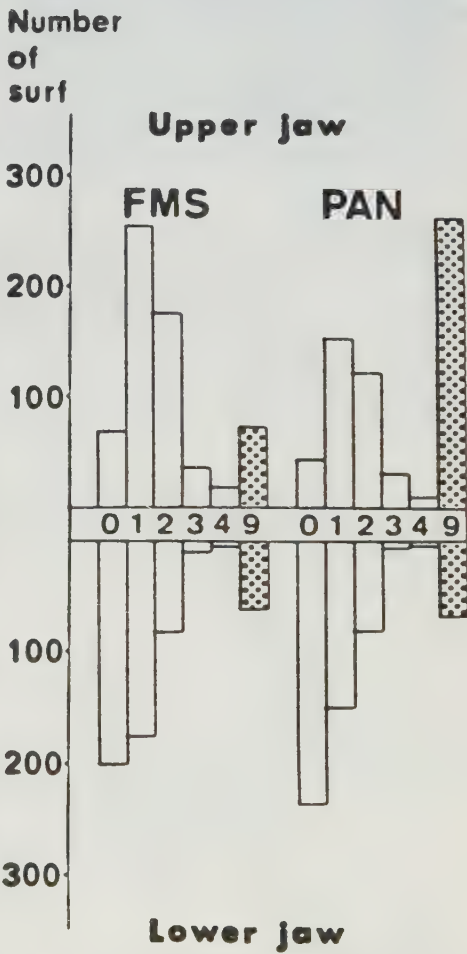


Fig. 3b. The distribution of different bone score units (value 0-4) on mesial and distal surfaces for the posterior regions in full mouth surveys (FMS) and panoramic radiographs (PAN). 9 = non-measurable.

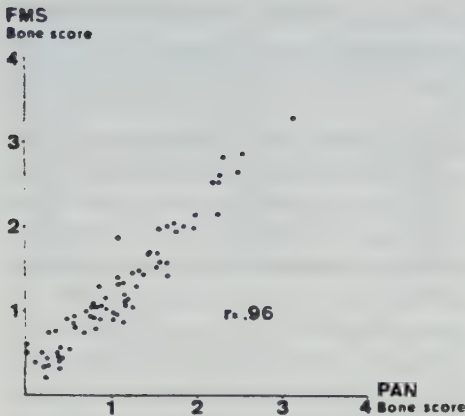


Fig. 4. Scatter diagram showing the individual mean bone scores in full mouth surveys (FMS) and panoramic radiographs (PAN).

Of the lesions within the dentine only 36% were diagnosed with both methods; the sensitivity was 41% and the specificity 98%. For lesions within the enamel only a 7% agreement was found between the method. The sensitivity was 7% and the specificity 100%.

Occlusal carious lesions were found both in FMS and panoramic radiographs in 16 cases. In one case an occlusal carious lesion was found in the panoramic radiograph but not in the FMS. Full agreement was obtained for gross carious lesions.

OTHER FINDINGS

Types and frequencies of "other findings" are shown in Table 9.

Table 7. Furcation involvements at premolars and molars. Number of radiographic findings in FMS and panoramic radiographs (PAN).

	FMS+PAN+	FMS+PAN-	FMS-PAN+
Upper jaw	21	6	7
Lower jaw	30	7	11
Total	51	13	18

Table 8. Number of proximal carious lesions of different depth in FMS and panoramic radiographs (PAN).

Region	FMS+PAN+		FMS+PAN-		FMS-PAN+	
	Enamel lesions	Dentinal lesions	Enamel lesions	Dentinal lesions	Enamel lesions	Dentinal lesions
Posterior, upper	2	34	17	47	0	8
Anterior, upper	0	29	7	41	0	13
Posterior, lower	2	34	17	43	0	5
Anterior, lower	0	9	10	25	0	8
Total	4	106	51	156	0	34

Table 9. Number of "other findings" found in FMS and panoramic radiographs (PAN).

Findings	FMS+PAN+	FMS+PAN-	FMS-PAN+
Pathology in connection with impacted teeth			
widened follicles	2	0	3
resorption of the crown	2	1	0
Mucosal thickening of the maxillary sinus	2	0	19
Nondental, isolated areas of			
a. osteolysis	5	0	1
b. osteosclerosis	6	1	5
Mesiodens	1	0	0
Foreign bodies	8	0	1

Table 10. Measurability of bone heights for full mouth survey and panoramic radiography (in per cent). Comparison with previous investigations.

	Year	Measurability %	
		FMS	PAN
<i>Björn & Holmberg</i>	1966	95.9	81.1
<i>Mutschelknauss & von der Ohe</i>	1978	94.4	78.8
<i>Adrianes et al.</i>	1982	87.3	86.8
<i>Present study</i>	1986	89.4	67.0

DISCUSSION

This study generally shows a good agreement between FMS and panoramic radiographs with respect to a large number of variables frequently used in epidemiological studies of dental health (*Björn* 1974, *Lysell* 1977, *Söderholm* 1979, *Halling & Bengtsson* 1981). This is not surprising since these variables include number of teeth, teeth with and without restorations and similar gross characteristics. To use a radiographic examination for only these variables would be to cause unnecessary irradiation of the patient. However, a radiographic examination is necessary if information about other pertinent variables such as periapical lesions, root fillings and marginal bone level is required. It also allows the need of treatment to be estimated. In addition, the radiograph is a lasting document which can be reevaluated at any time.

OSTEOLYTIC LESIONS AT THE ROOT

For single rooted teeth the majority of the discrepancies in diagnosis between the methods occurred in the upper anterior region which corroborates the results of *Gröndahl et al.* 1970, *Horton et al.* 1977 and *Stephens et al.* 1977. This finding can be related to the narrow "layer in focus" of the panoramic radiograph in the anterior regions. The broader "layer in focus" in the posterior regions is reflected in the high degree of agreement for multi-rooted teeth (90%) although the requirement that the lesions had to be placed on identical roots in order to be classified as agreement.

Recent models of panoramic apparatuses

produce a wider "layer in focus" in the anterior regions which allows a better view of the front teeth and thus a potential for a better agreement between FMS and panoramic radiographs than found in this study.

When widened periodontal ligament spaces were included the number of "false positive" diagnoses increased markedly for the panoramic radiographs. Earlier, *Horton* (1977) observed that "significantly more existing periodontal membrane changes were undetected in interpretations of FMS". This is an interesting observation which should warrant further elucidation.

MARGINAL BONE LOSS

In this study the measurability was consistent with previous studies for FMS, whereas for panoramic radiograph it was lower (Table 10). This does not imply, however, that the quality of the panoramic radiographs in this study was inferior to that of other studies because very stringent criteria were used for the acceptance of a surface as measurable in this study. Although the distribution of nonmeasurable surfaces were dissimilar for the two methods this did not seem to influence either the distribution of different bone score values (Fig. 3 a and b) or the mean bone scores for the two techniques (Fig. 4). The mandibular premolars and molars showed the highest degree of measurability for both methods which may partly explain the overall good agreement with respect to marginal bone level since these teeth have been shown to be representative for the whole dentition with respect to marginal bone level (*Björn et al.* 1975).

CARIOUS LESIONS

This study supports the results from earlier studies (*Hurlburt & Wuehrman* 1976, *Balis* 1981).

It is evident that lesions confined to the enamel are practically all missed in the panoramic radiograph. Even when only lesions in the dentine were considered the agreement was poor. It ought to be noted that four posterior bitewing radiographs were used together with the FMS but not with the panoramic radiograph. Beyond doubt the panoramic radiograph alone cannot be used for caries diagnosis not even for advanced lesions.

OTHER FINDINGS

As expected pathological changes within the maxillary sinuses were seen more frequently in the panoramic radiograph which is in accordance with the findings of *Björn et al.* 1967. Also osteosclerotic changes were seen more frequently in the panoramic radiograph. The most obvious reason for these differences is the limited area covered by the FMS compared with the panoramic radiograph.

CONCLUSIONS

The present study indicates that panoramic radiographs are in good agreement with FMS with respect to several variables of use in epidemiological studies of dental health. This prompts further studies on the possible application of panoramic radiography to dental practice since the method reduces both time and radiation dose compared with FMS. The use of panoramic radiography in epidemiological studies of dental health seems to be substantiated.

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II

Paper II

Dental status of Swedish middle-aged women as found in a population study in Göteborg, Sweden

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Key words: Dental status, edentulous, dentures, crowns, fillings, bone score, population study, women

ABSTRACT

Data are presented on the dental status of Swedish women representative of women in an urban area. The percentages of edentulous women increased from 4 in women aged 38 to 40 in women aged 60. About 40% of women aged 60 had full dentures. Among remaining teeth, 75-80% had fillings. Bone scores (bone score for the marginal bone level) were similar in women aged 46, 50 and 54 but lower in women aged 38 and higher in women aged 60.

SAMMANFATTNING

Från en populationsstudie av kvinnor i en svensk storstad presenteras resultat från den tandundersökning som ingick i studien. Andelen kvinnor som helt saknade tänder ökade från 4% hos 38-åriga kvinnor till 40% hos 60-åriga kvinnor. Ungefär 40% av alla kvinnor vid 60 års ålder hade helprotes. Av de tänder som fanns kvar hade 75-80% fyllningar. Bone scores (mått på benhöjden) var ungefär samma för kvinnor i åldrarna 46, 50 och 54 år men lägre hos 38-åriga kvinnor och högre hos 60-åriga kvinnor.

INTRODUCTION

An examination of the dental status was made when a comprehensive study of women was performed in Göteborg in 1968-1969. The population survey was meant to study the health of the women from many different points of view and included e.g. haematological, cardiovascular, gynaecological and psychiatric studies (Bengtsson *et al*, 1973).

The main reason for including a dental

study in the project was to throw light on:

1. The dental status of a non-selected series of women;
2. the interrelationships between certain somatic and psychological disorders and dental disease.

This article will give some basal data from the dental study. More detailed information will be given in forthcoming papers.

MATERIAL AND METHODS

Sampling procedure

An examination of the female population of Göteborg, Sweden in five age strata between 38 and 60 was carried out in 1968-1969. Altogether 1462 women were examined (Table 1). The total participation rate was 90.1%. The sampling process was made in such a way as to ensure that the women were representative of all women in Göteborg in the ages studied.

Further details about the sampling procedure and characterizations of the participants and non-participants in the study have been given elsewhere (Bengtsson *et al.* 1973).

Participation in the dental study

Altogether 1418 women participated in the special examination of the dental status (97.0% of those participating in the main study), as is shown in Table 1. Some characteristics of those women who participated in the main study but in whom for some reason the dental status was not examined are given in Table 2 and compared to those of women in the total population sample. The non-participants did not differ from the other women. In Table 2 women in various age strata are taken together, but similar results were found when the different ages were studied separately as well.

Table 1. Participants in the population study of women in Göteborg in 1968-1969 (participants in the main study and participants in the special part of the study devoted to the examination of the dental status).

Age, years	Total sample	Participants in the main study		Participants in the dental study		
	n	n	Participation rate (%) ¹	n	Participation rate ¹	Participation rate ²
38	407	372	91.4	356	87.5	95.7
46	479	431	90.1	421	87.9	97.7
50	436	398	91.3	391	89.7	98.2
54	203	180	88.6	172	84.7	95.6
60	97	81	83.5	78	80.4	96.3
Total	1622	1462	90.1	1418	87.4	97.0

¹Of those sampled.

²Of those participating in the main study.

Table 2. Some characteristics of participants and non-participants in the dental study.

	All participants in the main study (n = 1462)		Participants in the main study but not in the dental study (n = 44)	
	n	%	n	%
Married	1139	80	27	63
Unmarried	121	8	6	14
Divorced or separated	140	10	8	19
Widows	61	4	2	5
Grown-up in the Göteborg area	781	53	28	65
Grown-up in Sweden outside Göteborg	558	38	10	23
Grown-up outside Sweden	123	8	5	12
Grown-up in a rural area	417	29	9	21
Grown-up in an urban area	1043	71	34	79

Performance

The women were called at intervals of a quarter of an hour between 7.00 and 9.45 a.m. They passed the examination stations in a special consecutive order which has been described previously (Bengtsson *et al.* 1973). At one of these stations the examination of the teeth was performed. An x-ray of the teeth with a Paatero orthopantomograph (Paatero 1960) was taken by a trained dental nurse. If the films were not considered to be acceptable, the women were asked to come for a second x-ray.

The dental examination included also colour slides of the teeth and gums.

All the x-ray films were studied by one and the same examiner (A.H.), and the following variables were recorded: numbers of teeth missing, numbers of teeth being intact (teeth without fillings or other restorations, no caries detectable by means of orthopantomograph or colour slides), numbers of teeth with fillings, type of fillings and crowns.

Bone score measurement was performed (A.H.) according to the method described by Björn & Holmberg (1966). The evaluation of the bone scores was carried out during a 3-month period.

Statistical methods

Conventional methods were used for calculating mean value, standard deviation (S.D.) and standard error of the mean (S.E.).

RESULTS

Edentulous

In the total population sample 14% of the women had no own teeth. The percentages increased with age from 4% in women aged 38 to 40% in women aged 60 (Table 3).

Intact teeth

About 10% of the originally 32 teeth per women were intact ranging from about 15% in women aged 38 to 5% in women aged 60 as is also seen in Table 3. Calculated per numbers of the remaining teeth at the time of the examination and person the corresponding figures were found to range from 22 to 17%.

Number of remaining teeth

Fig. 1 shows cumulative percentages of women with respect to number of teeth remaining. Among the 38-year-old women 10% had lost 50% or more of their teeth compared to 70% who had lost 50% or more among those 60 years of age.

In Fig. 2 a description is given concerning presence or absence of each tooth in the various age strata studied. There was a continuous larger number of premolars and molars lost, and a larger number of teeth were preserved of the mandibular than of the maxillary teeth. The trend was similar in all the age strata studied.

Table 3. Prevalence of edentulous (total loss of own teeth, impacted teeth may be found), and percentages of intact teeth (teeth without fillings or other restorations, no caries detectable by means of orthopantomograph or colour slides).

Age, years	Total loss of own teeth		Intact teeth per 32 teeth and person	Intact teeth per remaining number of teeth and person
	n	%	%	%
38	15	4.2	15.5	22.4
46	45	10.7	11.6	20.9
50	71	18.2	10.0	21.9
54	39	22.7	8.8	20.0
60	31	39.7	4.6	17.3

Dentures

The distributions of women with different types of dentures are shown in Fig. 3. About 40% of women aged 60 had full dentures (dentures in one or both jaws and no own teeth). Dentures were less common in younger women.

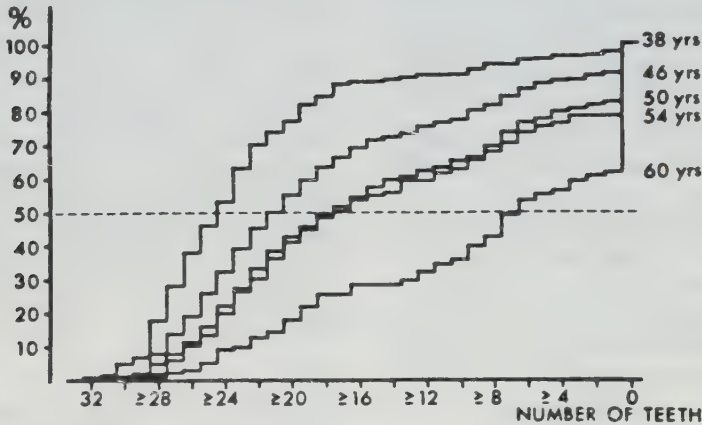


Fig. 1. Cumulative percentages of women with respect to number of teeth remaining.

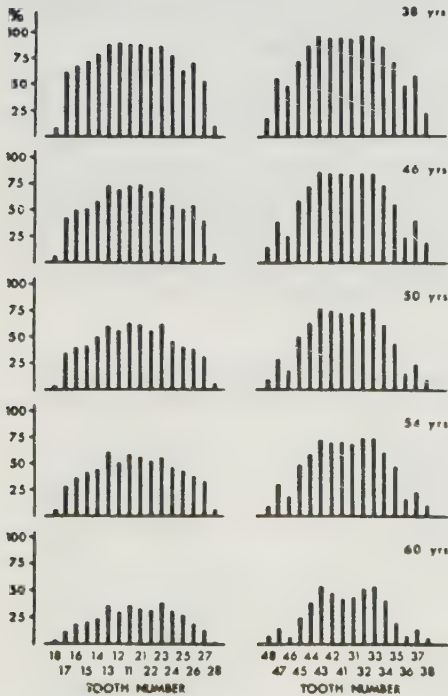


Fig. 2. Presence (%) of each special tooth in the various age strata studied.

Crowns

Calculated per 32 teeth and person the percentages of teeth provided with crowns were similar in the various age strata studied (Table 4), while the percentages increased from 11 in women aged 38 to 31 in women aged 60 when the calculations were based on the numbers of teeth remaining.

Fillings

Percentages of teeth with fillings are presented in Table 5. About 75–80% of the remaining teeth had fillings. There were no differences between the different age strata studied.

Endodontic treatment

Percentages of teeth which had been objected to endodontic treatment are shown in Table 6. About 10% of the original 32 teeth had been treated in this way, similar in the various age strata, while of those teeth remaining the percentages increased from 14% in women aged 38 to 28% in women aged 60.

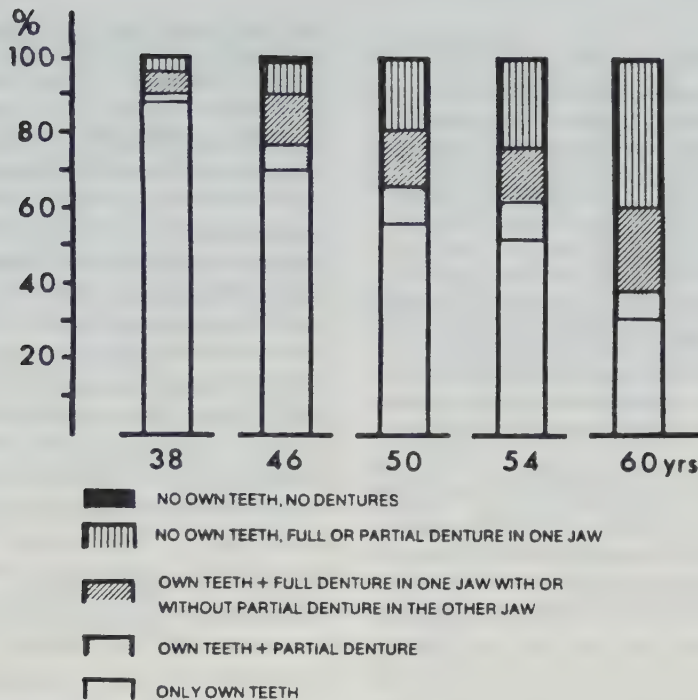


Fig. 3. Prevalence of full and partial dentures.

Table 4. Percentages of teeth with crowns by age.

Age, years	Per 32 teeth and person	Per remaining number of teeth and person
	%	%
38	7.8	11.2
46	10.2	18.4
50	10.5	22.9
54	11.1	25.2
60	8.1	31.0

Table 5. Percentages of filled teeth.

Age, years	Filled teeth per 32 teeth and person	Filled teeth per remaining number of teeth and person
	%	%
38	52.9	76.3
46	42.9	77.3
50	34.8	76.4
54	34.5	78.7
60	21.3	80.9

Table 6. Percentages of teeth with endodontic treatment.

Age, years	Per 32 teeth and person	Per remaining number of teeth and person
	%	%
38	9.9	14.2
46	10.4	18.8
50	9.4	20.7
54	9.7	22.1
60	7.4	28.1

Table 7. Bones scores values (mean score of all measurements in each participant).

Age, years	n	Mean	S.D.	S.E.
38	340	0.63	0.40	0.02
46	375	0.93	0.56	0.03
50	314	1.06	0.58	0.03
54	130	0.99	0.48	0.04
60	46	1.29	0.56	0.08

Bone score

Means of bone score for the marginal bone level are shown in Table 7. There were only small differences between women aged 46, 50 and 54, while the bone scores were definitely lower in women aged 38 and higher in women aged 60.

DISCUSSION

There are rather few studies which describe the dental status of subjects who are representative of the general population. Such information is important for many reasons. One reason is to learn what steps should be taken in order to improve the situation. Comparisons of the status at different times are also important in order to be able to evaluate the results of the various reforms meant to improve the dental status. As the way of chewing is important for many functions of the body and not least for the digestive system, it is also important to relate the dental status to other variables which measure the wellbeing of the subject (*Moulton et al.* 1952).

When a comprehensive population study of women was carried out in Göteborg, Sweden, it was also possible to include an examination of the teeth of the participants and of their dental hygiene status. A description of the situation as found in 1968–1969 is given in the present paper. There are two factors which make the present series extra valuable. One is the fact that it is known to be definitely representative of the general population of women in the age strata studied, the other that a large number of other factors were studied at the same time, which means that the dental status can be related to socio-economic factors, to internal medicine disorder, psychiatric disorders (*Landa* 1958) etc.

The choice of age strata instead of age groups in the present population study is also advantageous. In this way the influence of age can be more appropriately studied, as the women within each age stratum were of almost identical age, which had not been the

case if age groups with e.g. 5-year ranges had been used.

Age differences

There were obvious differences between the different age strata studied in many respects. These differences are probably related both to age per se and to other factors. The differences were not always the same between the different ages. E.g. it was found in Fig. 1 that there were very small differences between women aged 50 and women aged 54. It is probable that social reforms and better possibilities to visit a dentist in a stepwise way have improved the situation, and that the large differences between the various age strata studied thus only partly are referred to genuine age differences.

Comparisons with other studies

In the present study we found that 14% of the women had no own teeth. In corresponding ages the figures were similar as those found by *Håkansson* (1978) in women who were studied 5–6 years later and sampled from all Sweden and similar as in women in Stockholm (*Lavstedt* 1978). Our figures were lower than those found in one rural district in Sweden (*Sjöberg & Ståhle* 1972) but higher than in another district (*Axelsson et al.* 1975). Compared to a study in the U.S. (*Vital and Health Statistics* 1967), the percentages of edentulous women were similar in our study as for white women but somewhat higher than for black women in the U.S. study.

Our figures were also similar as those found for male staff members and workers in an industry in Malmö in the south of Sweden, who had been studied a few years before our study (*Björn* 1971).

The number of intact teeth has been calculated by means of orthopantomograms in the present study. Colour photographs have been of valuable help to estimate the condition in the anterior region of the mouth. In spite of this there will be an overestimation of the number of intact teeth, as the method for finding caries by means of orthopantomo-

graphs is not totally satisfactory (Björn 1971).

The percentages of filled teeth and of teeth with endodontic treatment out of those remaining were somewhat higher in women in Göteborg than among men studied in Malmö (Björn 1971).

The number of crowns per remaining teeth increased in our study from 11% in women aged 38 to 31% in women aged 60. The percentages were somewhat lower than those found by Håkansson (1978).

The bone score was calculated as a mean score from all surfaces measurable. Our findings are in agreement with those of Håkansson (1978), who found that the bone score above the age of 40 will underestimate the degree of periodontitis. The bone scores seemed to be somewhat lower in the present series of women than in the series of men studied in Malmö (Björn 1971).

Plans for the future

Important information can be obtained in a cross-sectional study like the present one. Even more valuable information can be obtained in a longitudinal study. A reexamination of the same women is taking place during 1980–1981, thus 12 years after the initial study. In this way it is possible to evaluate the effects of the new look concerning the dental care which have taken place since the study was carried out in 1968–1969.

ACKNOWLEDGEMENTS

The population study was supported by grants from R. and V. Andreen's Foundation, AB Astra, The Mutual Group Life Insurance Company "Förenade Liv", the Foundation of the Jubilee Clinic, Göteborg, the Swedish Nutrition Foundation, the Swedish Margarine Manufacturers Association and the Swedish National Association against Heart and Chest Diseases.

The analyses and presentation of data were supported by grants from the Swedish Medical Research Council 27x-4578 and from the Faculty of Medicine, University of Göteborg.

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III

Paper III

Number of teeth and proximal periodontal bone height in relation to social factors

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Key words: *Loss of teeth, alveolar bone height, radiographs, social factors, population study, women*

ABSTRACT

The dental status with respect to number of missing teeth and proximal periodontal bone height in relation to social factors were studied in a population sample of women 38-60 years of age. There was an overrepresentation of edentulous women among those who had grown up in a rural area, who had low education, and in those who belonged to a low socio-economic group (irrespective of whether the socio-economic group of the women themselves or of their husbands was studied), while no obvious differences were observed when the proximal periodontal bone height was studied in relation to social factors. The relationships between social factors and number of missing teeth seemed to be stronger than between social factors and any other variable included in the comprehensive population study, of which this examination of the dental status was one of a number of research projects.

SAMMANFATTNING

I en populationsstudie av kvinnor i åldrar mellan 38 och 60 år relaterades antalet saknade tänder och marginal benhöjd till sociala faktorer. Det var en överrepresentation av kvinnor som helt saknade tänder bland dem som vuxit upp i landsbygdsområde, som hade låg utbildning och hos dem som tillhörde en låg socialgrupp (det senare oberoende av om hänsyn togs till kvinnans egen eller till makens socialgrupps tillhörighet). Däremot fanns det inga klara skillnader när marginal benhöjd studerades på motsvarande sätt i relation till sociala faktorer. Det föreföll som om sambandet mellan sociala faktorer och antal förlorade tänder var starkare än mellan sociala faktorer och någon annan variabel som studerats i samband med denna omfattande populationsstudie, där tandundersökningen är ett av flera delprojekt.

INTRODUCTION

An examination of the dental status was included when a comprehensive study of women in Gothenburg was performed in 1968-69. The population survey was meant to study the health of the women from many different points of view and included a number of various studies e.g. concerning haematological, cardiovascular, gynaecological and psychiatric

problems (Bengtsson *et al.* 1973 a). A description of the dental status of the participants in the population study has been presented previously (Halling & Bengtsson 1981). The purpose of this paper is mainly to relate the dental status to the socio-economic status of the participating women and of their husbands. Place of growing-up of the participants and education are also taken into consideration.

STUDY POPULATION

An examination of the female population of Gothenburg, Sweden, in the age strata 38, 46, 50, 54 and 60 was carried out in 1968-69. Altogether 1462 women participated. The overall participation rate was 90.1 %. Further details of the sampling procedure and characteristics of the participants and non-participants in the study have been given elsewhere (*Bengtsson et al 1973 a*).

Altogether 1418 of these women participated in the special examination of the dental status (97.0 % of those who participated in the main study). Some characteristics of those who participated in the main study, but in whom for some reason the dental status was not examined, have been given previously together with data on the dental status of women in the total population sample (*Halling & Bengtsson 1981*). Number of participants and participation rates in the five different age strata are given in Table 1.

METHODS

The women were called at intervals of a quarter of an hour between 7.00 and 9.45 a.m. They passed the examination stations in a special consecutive order (*Bengtsson et al 1973 a*). At one of these stations the examination of the teeth was performed. An x-ray of the teeth with a Paatero orthopantomograph (*Paatero*

1960) was taken by a trained dental nurse. If the films were not considered to be acceptable, the women were asked to come for a second x-ray. All the x-ray films were studied by one and the same examiner (A. H.). Numbers of missing teeth were recorded. Marginal bone level measurement (bone score) was performed (A. H.) according to the method described by *Björn & Holmberg (1966)*. The evaluation of the bone score was carried out during a 3-month period.

Information about place of growing-up, education and socioeconomic group was obtained by means of a questionnaire. The women were asked whether they had grown up in a city, town, other urban district or in a rural district. The subjects were classified into five social groups according to *Carlsson (Carlsson 1956, Carlsson 1958, Bengtsson et al 1973 b)*. Group 1 according to this classification is in the present paper presented as socio-economic group I (large scale employers and officials of high and intermediate rank), groups 2 and 3 as socio-economic group II (small scale employers, officials of lower rank, foremen) and groups 4 and 5 as socio-economic group III (skilled and unskilled workers).

STATISTICAL METHODS

Conventional methods were used for calculating mean values and standard deviations (SD). The hypothesis of no difference between mean values was tested by means of analysis of variance. For analysis of frequencies, the chi²-test was used, or, when including all age strata in the same analysis, the extension of the chi²-procedure according to *Mantel-Haenszel* with one degree of freedom (*Mantel 1963*). In this way the effect of age as a confounding factor is minimised.

The hypothesis of no differences between mean values was tested with Student's t-test. Differences were tested at the levels $p < 0.10$, $p < 0.05$, $p < 0.01$ and $p < 0.001$ ($p < 0.05$ was considered as statistically significant level).

Table 1. Participants in the dental study and participation rate (percentage of those sampled).

Age (years)	n	Participation rate (%)
38	356	87.5
46	421	87.9
50	391	89.7
54	172	84.7
60	78	80.4
Total	1418	87.4

RESULTS

NUMBER OF TEETH IN RELATION TO PLACE OF GROWING-UP

In Fig. 1 the number of lost teeth is shown in relation to place of growing-up. Women aged 38, 50 and 60 are included in the figure. There is a tendency for an increased number of lost teeth in women who have grown up in rural areas compared to women grown up in cities or towns. Significant changes were found for women aged 46 and 60 and for the total population sample (a larger number of women born in rural areas being edentulous) as shown in Table 2.

NUMBER OF TEETH IN RELATION TO EDUCATION

Number of lost teeth in relation to education in the different age strata studied is shown in Fig. 2. A larger number of teeth had been lost in the upper ages and in women with lower

levels of education. In women 38 years of age 53 % had lost > 8 teeth among those women who had attended primary school only, and corresponding figure was 29 % for women with high school studies. Among women aged 60 corresponding figures were 95 % and 50 % respectively. A higher percentage of edentulous

Table 2. Numbers and percentages of edentulous women in relation to place of growing-up (NS = no statistical significance).

Age yrs	Rural n	area %	Urban n	area %	Statistical significance
38	3/90	3.3	11/265	4.2	NS
46	20/137	14.6	22/282	7.8	$p < 0.05$
50	27/115	23.5	43/274	15.7	($p < 0.10$)
54	10/44	22.7	29/128	22.7	NS
60	13/23	56.5	17/55	30.9	$p < 0.05$

Total sample: $p < 0.01$

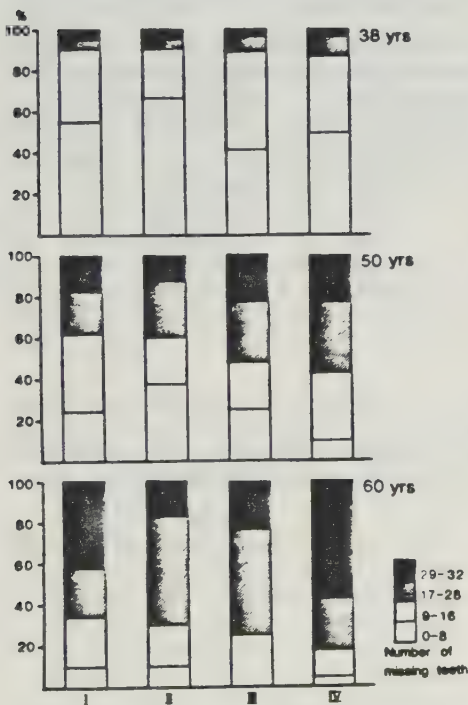


Fig. 1. Numbers of missing teeth in relation to place of growing-up (I = city, II = town, III = other urban area, IV = rural area).

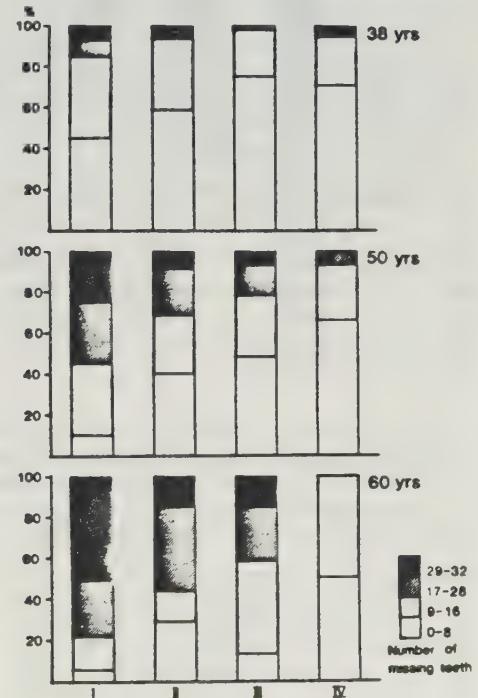


Fig. 2. Numbers of missing teeth in relation to education (I = elementary school only, II = interrupted middle school, III = middle school examination, IV = high school studies).

ous women was observed among women who had only attended elementary school than in women with further education in all the age strata studied (Table 3).

NUMBER OF TEETH IN RELATION TO WOMEN'S SOCIO-ECONOMIC STATUS

Fig 3 shows number of lost teeth in relation to the socio-economic group of the women. As only a few women were classified into socio-economic group I (51 altogether), Fig. 3 shows the situation for the total population sample. The higher socio-economic group, the lower number of teeth lost. Table 4 shows numbers of edentulous women in the different age strata with respect to socio-economic group. Differences of statistical significance were observed between socio-economic groups I-II and III in all age strata except for women aged 38, and also in the population sample as a whole.

Only those women who were employed outside home were classified into different socio-economic groups. Women who did not work outside home were studied separately and compared to women who did work outside home. No differences were observed between women who worked and who did not work outside home.

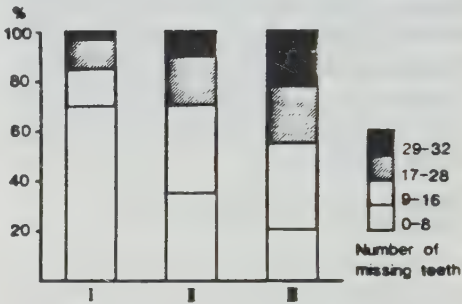


Fig. 3. Numbers of missing teeth in relation to socio-economic group of the participating women.

Table 3. Numbers and percentages of edentulous women in relation to education.

Age yrs	Elemenatary school only		Further education after elementary school		Statistical significance
	n	%	n	%	
38	14/238	5.9	0/118	0.0	p < 0.01
46	41/284	14.4	1/137	0.7	p < 0.001
50	64/273	23.4	7/116	6.0	p < 0.001
54	37/127	29.1	2/45	4.4	p < 0.001
60	29/61	47.5	1/16	6.3	p < 0.01

Total sample: p < 0.001

Table 4. Numbers and percentages of edentulous women in relation to socio-economic group of the participating women (NS = no statistical significance).

Age yrs	Socio-economic groups						Statistical significance of difference			
	I		II		III		I-II	I-III	II-III	I-II - III
	n	%	n	%	n	%				
38	0/14	0.0	4/108	3.7	7/86	8.1	NS	NS	NS	NS
46	0/16	0.0	14/147	9.5	21/118	17.8	NS	(p < 0.10)	p < 0.05	p < 0.05
50	0/8	0.0	17/122	13.9	28/115	24.3	NS	NS	p < 0.05	p < 0.05
54	1/9	11.1	3/44	6.8	16/48	33.3	NS	NS	p < 0.01	p < 0.01
60	0/4	0.0	2/13	15.4	9/22	40.9	NS	NS	NS	p < 0.05
Total							(p < 0.1)	p < 0.001	p < 0.001	p < 0.001

NUMBER OF TEETH IN RELATION TO THE SOCIO-ECONOMIC GROUP OF THE HUSBANDS

Number of lost teeth among the participating women in relation to the socio-economic group of their husbands is shown in Fig. 4. Women aged 38, 50 and 60 are included in the figure. It is to be observed that there are rather few women in the different socio-economic groups among women aged 60 (Table 5).

Again the same thing is observed concerning socio-economic group of the husbands: the higher socio-economic group, the lower number of teeth has been lost by the participating women. As shown in Table 6, differences of statistical significance were observed for women aged 46, 50 and 54 and for the total population sample.

Table 5. Numbers and percentages of edentulous women among those who did not work outside home in comparison with women who were employed outside home (NS = no statistical significance).

Age yrs	No work out- side home		Work outside home		Statistical significance
	n	%	n	%	
38	4/143	2.8	11/197	5.6	NS
46	10/129	7.8	35/246	14.2	($p < 0.10$)
50	21/125	16.8	45/200	22.5	NS
54	17/61	27.9	20/81	24.7	NS
60	13/27	48.1	11/28	39.3	NS

Total sample: ($p < 0.10$)

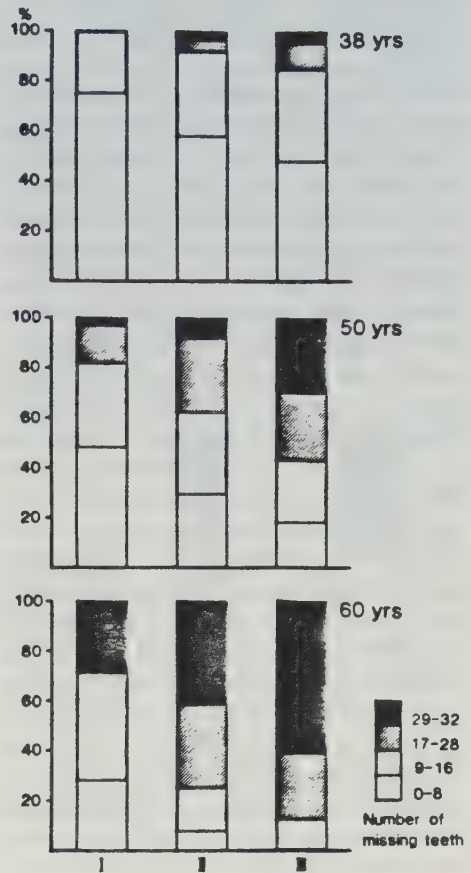


Fig. 4. Numbers of missing teeth in relation to socio-economic group of husbands of the participating women.

Table 6. Numbers and percentages of edentulous women in relation to socio-economic group of the husbands of the participating women (NS = no statistical significance).

Age yrs	Socio-economic groups						Statistical significance of difference			
	I		II		III		I-II	I-III	II-III	I-II - III
	n	%	n	%	n	%				
38	0/27	0.0	4/129	3.1	5/95	5.3	NS	NS	NS	NS
46	1/54	1.9	8/127	6.3	26/144	18.1	NS	$p < 0.01$	$p < 0.01$	$p < 0.001$
50	1/47	2.1	10/130	7.7	40/133	30.1	NS	$p < 0.001$	$p < 0.001$	$p < 0.001$
54	1/17	0.0	12/54	22.2	21/60	35.0	$p < 0.05$	$p < 0.01$	NS	$p < 0.05$
60	2/7	28.6	5/13	41.7	14/24	58.3	NS	NS	NS	NS
Total							$p < 0.01$	$p < 0.001$	$p < 0.001$	$p < 0.001$

NUMBER OF TEETH IN RELATION TO INCONGRUITY CONCERNING SOCIO-ECONOMIC GROUP OF THE PARTICIPANT AND HER HUSBAND

Fig. 5 shows the number of lost teeth in women who belonged to other socio-economic group than their husbands. Only women aged 50 are included in the figure, but the results were similar in the other age strata as well. In the left columns the husbands were classified into socio-economic groups I-II, while the women were classified into socio-economic group III. In the right columns of

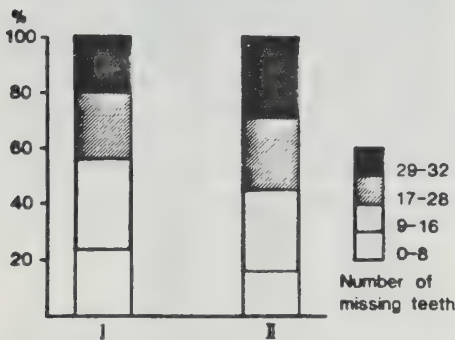


Fig. 5. Numbers of missing teeth in relation to combinations of social groups concerning the participating women and their husbands (incongruity concerning socio-economic groups). Only 50-year-old women are included in the figure.

the figure the situation was the opposite. No differences of statistical significance were observed (Table 7).

BONE SCORE IN RELATION TO SOCIAL FACTORS

Bone score in relation to socio-economic group of the participating women themselves and of their husbands are shown in Table 8 in the different age strata studied. There seems to be no general tendency when the bone score was related to socio-economic status in the different age strata studied. Only in women aged 38 a difference of statistical

Table 7. Numbers and percentages of edentulous women in relation to combination of their own and their husbands' socio-economic groups (NS = no statistical significance).

Age yrs	Participating women I-II, husbands III		Participating women III, husbands I-II		Statistical significance
	n	%	n	%	
38	1/27	3.7	2/31	6.5	NS
46	6/40	15.0	3/28	10.7	NS
50	9/313	29.0	4/25	16.0	NS
54	1/10	10.0	3/8	37.5	-
60	1/1	100.0	0/1	0.0	-

Total sample: NS

Table 8. Bone score in relation to socio-economic group of the participating women and of their husbands.

Age yrs	I			II			III		
	n	Mean	SD	n	Mean	SD	n	Mean	SD
Socio-economic group of participant									
38	13	0.64	0.24	90	0.73	0.43	66	0.57	0.38
46	15	0.61	0.32	110	0.96	0.55	90	0.96	0.61
50	10	1.01	0.52	93	1.08	0.57	70	1.06	0.58
54	7	0.83	0.39	28	0.98	0.49	25	0.90	0.56
60	4	1.28	0.39	8	1.52	0.70	9	1.21	0.59
Socio-economic group of husband									
38	39	0.56	0.31	115	0.62	0.38	86	0.68	0.47
46	54	0.81	0.45	104	0.88	0.49	108	1.03	0.69
50	49	0.92	0.51	95	1.05	0.62	78	1.09	0.65
54	16	0.90	0.53	28	0.99	0.47	32	1.00	0.46
60	5	1.06	0.46	6	1.77	0.25	7	1.28	0.77

significance was observed (lower score in socio-economic group III than in II, $p < 0.05$).

No differences of statistical significance were obtained when bone score was related to place of growing-up or to education.

DISCUSSION

The variables from the special dental study has in this paper been confined to the number of lost teeth and bone score for the marginal bone level, as these variables have been considered the most important ones.

There are previous studies indicating an association between social and socio-economic factors such as educational level (*Kelly et al.* 1967, *Smedby* 1972, *Anderson et al.* 1974, *Håkansson* 1978, *Österberg* 1981) and socio-economic group (*Gray et al.* 1970, *Smedby* 1972, *Anderson et al.* 1974, *Nyman* 1975, *Lehtinen* 1975, *Lysell* 1977, *Norheim* 1977) on the one hand and dental status on the other.

In the population study described in this paper, the dental status could be related to place of growing-up, level of education and socio-economic group. The socio-economic status of the husbands of the participating women has also been included. We think that the results obtained in this study are of special interest, as the participants in our study are representative of women in the general population in the age strata studied due to the way of sampling and a high participation rate.

In the present study marked differences in dental status with respect to number of remaining teeth were found between different socio-economic groups, which is in accordance with the results from previous studies (*Smedby* 1972, *Anderson et al.* 1974, *Nyman* 1975, *Norheim* 1977). *Gray et al.* (1970) showed that the association between social classifications and tooth loss was of less importance in urban areas. *Lehtinen* (1975), and *Lysell* (1977) did not find any difference between social group and number of missing teeth.

The number of women with missing teeth was in our study found to be inversely related to rising levels of education which is in accordance with *Kelly et al.* (1969), *Smedby* (1972), *Anderson et al.* (1974), *Håkansson* (1978), and *Österberg* (1981).

In the present study similar differences were observed whether the dental status was related to the socio-economic group of the woman herself or of her husband. On the other hand, no difference was found between women who worked in their homes but not outside home and women who worked also outside home, which is opposite to the results reported by *Gray et al.* (1970), who reported such a difference.

No definite association was in this study found between socio-economic status and bone score. This is in agreement with *Lysell* (1977) who examined a population of 67-year-old Swedes and found only small differences in marginal bone score between the socio-economic groups. *Norheim* (1979) studied a population of Norwegians 20-69 years of age and found modest differences. *Markkanen et al.* (1981) found in a population in Finland of subjects 30-45 years old that the differences in marginal bone loss were to a very small extent correlated to socio-economic group differences. Comparing education and marginal bone score, *Russel & Ayers* (1960), *Anderson et al.* (1974) and *Håkansson* (1978) found with increasing education lower bone scores i.e. better attachment of the teeth. *Dunbar et al.* (1968) and *Markkanen et al.* (1980) did not find a consistent association between marginal bone loss and educational level.

The assessment of marginal bone loss, as a mean of all measurable boneheights in the dentition, is complicated. Loss of teeth with advanced periodontitis will lower the mean bone score for the individual. This effect will be more pronounced from 40 years of age (*Håkansson* 1978). Another complicating factor is that teeth will be earlier extracted in lower socio-economic groups which will un-

derestimate the severity of marginal bone loss in these groups (Anderson *et al.* 1974).

As stated above, marked differences in dental status were observed between different socio-economic groups in the present study. In fact, the correlation between socio-economic group and dental status seemed to be stronger than between socio-economic group and any other variable studied in our comprehensive population study, in which many different variables have been included (Bengtsson *et al.* 1973 a).

In this study no consideration has been taken to social mobility (Beal & Dickson 1975). The data presented here were carried out in 1968-69, and it is possible that the influence from socio-economic status was more important at that time than today.

It is therefore of great interest to re-study the population sample in order to find out whether social reforms including improved dental care has diminished the differences between women in different socio-economic groups and differences concerning other social factors. Such an evaluation is now in progress.

ACKNOWLEDGEMENTS

The population study was supported by grants from R. and V. Andrén's Foundation, AB Astra, the Mutual Group Life Insurance Company "Förenade Liv", the Foundation of the Jubilee Clinic, Gothenburg the Swedish Nutrition Foundation, the Swedish Margarine Manufacturers Association and the Swedish National Association against Heart Diseases. Premises were made available by the City of Gothenburg. The analyses and presentation of data were supported by grants from the Swedish Medical Research Council (27X-4578), from the Faculty of Medicine in Gothenburg and from the Faculty of Odontology in Malmö.

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IV

Paper IV

Periodontal status in relation to age of dentate middle aged women

A 12 year longitudinal and a cross-sectional population study

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Key words: Epidemiology, alveolar bone height, radiographic assessment, tooth loss, longitudinal study, cross-sectional study.

ABSTRACT

The periodontal status was studied by means of orthopantomography in one prospective and one cross-sectional cohort study of representative samples of dentate middle aged women living in Gothenburg.

The proximal bone height was assessed by measurements on the roentgenographs by aid of a five degree scale. Since loss of teeth in middleaged persons often is due to periodontal disease, also tooth loss was registered.

The prospective study: Eight hundred and sixty-two women belonging to age strata 38, 46, 50, 54 and 60 years and born on certain dates were examined in 1968 and were re-examined in 1980.

The average number of teeth lost during the 12 year observation period varied from 1.7 to 3.3 in the different age strata and the average alveolar bone height had been reduced in all age groups. About 83 per cent of the participants had a mean bone height of the same magnitude at both occasions, while about 5 per cent showed a considerable progression of bone loss. The percentage of individuals showing greater bone loss was the lowest among those who were 50 years old at the first examination. The progression of bone loss during the observation period did not seem to be related to the initial periodontal status.

The cross-sectional cohort study included four samples, viz. 38 and 50 years old women from each of the 1968 and 1980 examinations.

Some improvement of the dental state had occurred from 1968 to 1980 as evidenced from the number of remaining teeth. The 38 year old women had on an average 2.1 teeth more in 1980 compared to participants of the same age 12 years earlier. In 50 year old women the corresponding figure was 2.5 teeth. The percentage of 38 year old women with ≥ 22 remaining teeth had increased from about 73 to 90 per cent in the 1968 and 1980 cohorts respectively. The corresponding figures for 50 year old women were 48 per cent in 1968 and 67 per cent in 1980. Also the periodontal state was somewhat better in the 1980 cohorts: More than 65 per cent of the women in the 38 year cohort had only slight bone loss in 1980 compared to 49 per cent in the 1968 one. In the 50 year old cohort 32 per cent of the women showed only a slight bone loss in 1980 compared to 23 per cent in 1968.

SAMMANFATTNING

Parodontalstatus studerades med hjälp av ortopantomografisk registrering i en longitudinell och en tvärsnitts-kohortundersökning av representativa samples av medelålders kvinnor i Göteborg.

Den proximala parodontala benhöjden mättes på röntgenbilderna med en 5-gradig skala. Eftersom tandförluster hos medelålders personer mycket ofta betingas av parodontit, registrerades även tandförluster.

Longitudinell studie: 862 kvinnor inom åldersstrata 36, 46, 50, 54 och 60 år födda på vissa dagar undersöktes år 1968 och en andra gång år 1980. Det genomsnittliga antalet tänder som förlorats under den 12-åriga observationstiden varierade från 1.7 till 3.3 inom de olika åldersstrata och den genomsnittliga alveolära benhöjden hade reducerats i alla åldersgrupper. Cirka 83% av deltagarna hade en genomsnittlig benhöjd av samma storleksordning vid båda undersökningarna medan omkring 5% visade en avsevärd minskning av benhöjden. Procenttalet individer som visade stor benförlust var lägst bland dem som vid första undersökningen var 50 år gamla. Benförlusterna under observationstiden tycktes icke vara relaterade till det initiala parodontalstatus.

Tvärsnittsstudien omfattade fyra samples, nämligen 38 och 50 år gamla kvinnor från var och en av undersökningarna 1968 och 1980. Att en viss förbättring av tandstatus hade ägt rum från 1968 till 1980 framgick bl.a. av antalet kvarvarande tänder. Trettioåttåringarna av 1980 hade i medeltal 2.1 fler tänder än lika gamla deltagare 12 år tidigare. Hos 50-åringarna var motsvarande medeltal 2.5 tänder.

Procenttalet 38-åriga kvinnor med ≥ 22 kvarvarande tänder hade ökat från cirka 73 till omkring 90%. Motsvarande siffror för 50-åringarna var 48% år 1968 och 67% år 1980.

Även den parodontala benhöjden var något bättre hos 1980 års samples: Mer än 65% av kvinnorna i 38-års samplen hade endast obetydliga benförluster jämfört med 49% i 1968-års samplen. För 50-åringarna var motsvarande procenttal 32% år 1980 jämfört med 23% år 1968.

INTRODUCTION

During the last few decades many actions have been taken in order to cope with the high rate of dental diseases in Sweden. The first step was to increase the dentist to population ratio. When it was found that the increased availability of the traditional reparative dental care did not solve the problem, a gradual change towards a more prevention oriented one occurred. In this process new types of dental manpower became necessary: dental hygienists and prophylaxis assistants were employed above all in Public Dental Health Service. Finally, in 1974, a general dental health insurance was instituted with the aim of making "good dental care available to all citizens at a reasonable cost".

These measures have had a considerable impact on the average dental state in this country as is evidenced by reports from numerous epidemiologic studies. There is a consensus about a decreasing number of

edentulous persons in the adult population as well as an increasing number of remaining teeth among dentate ones. It is not clear to what degree this can be ascribed to a real improvement of dental health and what part is played by changing attitudes towards the indications for extractions. These indications are today considerably more restrictive than during earlier decades.

Traditionally the sequelae of caries were those dental problems that were remedied in the first place, while periodontal disease was only secondly or not at all attended to. The increase in number of remaining teeth may to an unknown extent be due to the conservation of cariologically treated but periodontally affected teeth rather than to an overall improvement of the dental health. Consequently it may be of great interest to study the periodontal status in detail and even more so to assess the progression of

periodontal breakdown over a reasonably extended period of time. In longitudinal studies of the periodontal state, the roentgenogram is an exceedingly valuable tool since the registrations can be repeated and re-evaluated whenever indicated. This gives clear benefits compared to clinical recording.

Earlier studies have shown that investigations on progression of periodontal disease in populations below 40 years of age are not rewarding due to the fact that up to this age the average periodontal bone loss is too small to be of more than marginal interest (*Löe et al.* 1978).

The present study on the periodontal bone changes during a 12 year observation period is part of a dental health investigation, which started in Gothenburg, Sweden, in 1968. It was followed up by a second examination 12 years later in 1980.

AIM

The aim of the present investigation was to estimate the periodontal status as revealed by radiographs in:

- a longitudinal cohort study of five age strata
- a cross-sectional cohort study of 38 and 50 year old women.

MATERIAL

The samples used in this investigation were collected during a medical study of middle-aged women in Gothenburg (*Bengtsson et al.* 1973). The sampling was made by selecting all females in the population register in age strata 38, 46, 50, 54 and 60 years who on January 1, 1968 were recorded as residents in Gothenburg and born on certain dates. At a second examination 12 years later, the participants included in the five strata were 50, 58, 62, 66 and 72 years old, respectively. In 1980 a new group of 38 year old women was sampled in the same way as described above. Further

details about participation and dropping-out have been given elsewhere (*Bengtsson et al.* 1973, *Halling & Bengtsson* 1981). In order to facilitate the description the groups will below be identified by 38/50, 46/58 and so on.

LONGITUDINAL COHORT STUDY

The studied sample comprised 862 individuals living in Gothenburg in 1968 and remaining there in 1980, dentate at both occasions and having measurable periodontal bone heights on radiographs.

CROSS-SECTIONAL COHORT STUDY

The samples comprised

- 340 individuals, 38 year old in 1968 and
- 107 individuals, 38 year old in 1980.

The 1968 cohort included all dentate individuals examined in 1968.

- 223 individuals, 50 years old in 1968 and
- 264 individuals, 50 years old in 1980.

The 50 year old women were identical with those in the longitudinal study. In order to get strictly comparable cohorts only those individuals in the 1968 cohort who had participated in the 1980 examination are taken into consideration in this report.

METHODS

The investigation was performed in 1968 at the Sahlgren Hospital and in 1980 at the department of Oral Radiology, University of Gothenburg. The dental status of the participants was recorded by orthopantomography (*Paatero* 1960). The technical work was throughout the whole study in 1968 performed by one specially trained dental assistant. In 1980 the corresponding work was made by the personnel at the department of Oral Radiology. The examinations were carried out within a 12-month period at each occasion.

In 1968 colour photographs were obtained, which depicted the anterior parts of the dentitions.

The periodontal bone height as well as the number of remaining teeth were evaluated in the assessment of the periodontal state. The motive for including remaining teeth is the fact that extractions of teeth in individuals over 40 years of age to a considerable extent are caused by advanced periodontitis (Cahen *et al.* 1985).

Bone heights and number of remaining teeth were evaluated by one of the authors (AH) within a four month period in 1968 and 1980 respectively.

The interproximal bone heights expressed as "bone scores" were determined on mesial and distal tooth surfaces by means of a plastic ruler (Fig. 1) according to a method described by Björn & Holmberg (1966). One interval on the scale here corresponds to one fourth of the root length. The scale thus comprised bone scores 0–4.

The bone height was considered as interpretable if the entire outline of crown and apex of the tooth as well as the proximal bone structure could be identified in the roentgenogram. Image defects making interpretation impossible were: blurring, low contrast, superposition of background structures and overlapping of teeth.

Individual mean bone score values served as a basis for calculating the mean values for the whole group. The results were coded on mark forms, one form per participant for each of the two examinations. In 1980 the individual teeth were identified by comparing the actual roentgenographs with the correspond-

ing ones from 1968. The analyses were based not only on roentgenographs since colour photographs proved to be a valuable complement.

The individual mean bone score values were grouped in 0.3 unit intervals from BSC 1 = 0–0.29, BSC 2 = 0.3–0.59 and so on to facilitate the assessment of frequency distributions and the evaluation of progression of marginal bone loss.

REPRODUCIBILITY

In 1982 the intraexaminer (AH) reproducibility of bone height measurements was tested on 50 orthopantomograms, randomly chosen from the 38 year group of the 1968 study. Thus 12 years had passed since the first recording. The reproducibility was evaluated by comparing the individual means calculated at the two occasions. The frequency distribution of differences of individual means evaluated with 12 years interval is given in Table 1. Forty-four per cent were registered somewhat higher and 50 per cent lower at the second recording. The mean difference was 0.025 and the standard error of the mean 0.020 scale divisions.

Table 1. Frequency distribution of differences of individual means evaluated at two occasions with 12 years interval.

Diff	n	cum%
0.0	3	6
0.01–0.10	25	56
0.11–0.20	16	88
0.21–0.30	4	96
0.31–0.40	1	98
0.41–0.50	1	100

Mean difference 0.025 (S.e. 0.020).

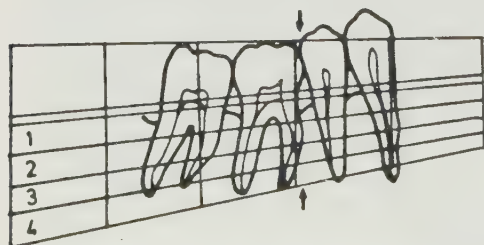


Fig. 1. Ruler used for measuring bone heights. Scale fitted to image the mesial surface of the right first molar. The bonescore on this specific site is one.

The consistency of the bone heights obtained by use of orthopantomograms in relation to assessment based on intraoral radiographs was evaluated by Ahlqwist, Halling & Hollender 1986.

STATISTICS

Since the frequency distributions of bone scores and bone score means were strongly skewed and since inhomogeneity of variances were common, non-parametric statistical methods (Wilcoxon's and Mann-Whitney's tests, Chi-square tests) were chosen for analyzing the results.

RESULTS

The distribution of participation on age strata is illustrated in Table 2. The rate of participation in the longitudinal study was 82.3 per cent on an average, varying from 66.6 per cent in the oldest to 85.6 per cent in 50/62 year old group. The dropping-out was due to the fact that 195 women refused to participate in the

Table 2. Distribution of participants and nonparticipants in the longitudinal on cohort studies (* = coh; ** = long + coh).

Age group	Available population 1968 and 1980	Dropouts	Participants 1968 and 1980	Toothless 1980	Dentate	Nonmeasur boneheights	Studied population
38/50	314	46	268	4	264	0	264 **
46/58	339	69	270	10	260	2	258
50/62	285	41	244	19	225	2	223 **
54/66	123	26	97	3	94	0	94
60/72	39	13	26	2	24	1	23
Total	1100	195	905	38	867	5	862

	Participants	Toothless	Dentate	Nonmeasur boneheights	Studied population
38/1968	356	14	342	2	340 *
38/1980	109	2	107	0	107 *

second examination, while 38 became edentulous during the 12-year interval and 5 had non-measurable bone heights. Thus the final sample in the longitudinal study comprised 862 women.

The participation rate in the 38 year cohort from 1980 was 74.7 per cent. The percentages of edentulous 38 year old women were 2.9 per cent in the 1968 and 1.8 per cent in the 1980 cohort. Table 3 presents the mean numbers of remaining teeth in the longitudinal as well as in the cross-sectional cohort study. The 60 year old women had on an average 7.0 teeth less than the youngest ones in 1968. This difference had increased to 8.6 in 1980. The number of teeth extracted during the observed period varied from 1.7 in the youngest to 3.3 in the oldest age group. In the cohort study the 38 year old women had on an average 2.1 and the 50 year old women 2.5 more remaining teeth in 1980 compared to the same age groups 12 years earlier.

The distribution of remaining teeth on 38 year old dentate women in 1968 and 1980 is shown in Table 4a. The percentage of women with ≥ 22 remaining teeth, i.e. women having at least two molars, had increased from 72.6 per cent to 88.0 per cent in 1968 and 1980 respectively.

Table 4b illustrates the distribution of remaining teeth of 50 year old individuals in 1968 and 1980. The corresponding figures for

remaining teeth were 48.4 per cent and 67.4 per cent in 1968 and 1980 respectively.

The distributions differ significantly in both cohorts ($p < 0.001$). In Table 5 the means of bone score values for the longitudinal as well as for the cross-sectional studies are presented. The bone scores were higher in the older age groups at both examinations ($p <$

Table 4. Distribution of number of remaining teeth on examination year.

A. The 38 year cohort	1968		1980	
	n	%	n	%
Number of teeth				
1- 7	8	2.4	3	2.8
8-14	15	4.4	1	0.9
15-21	70	20.6	7	6.5
22-28	220	64.7	76	71.0
29-32	27	7.9	20	18.7
Total	340		107	

B. The 50 year cohort	1968		1980	
	n	%	n	%
Number of teeth				
1- 7	17	7.6	10	3.8
8-14	28	12.6	18	6.8
15-21	70	31.4	58	22.0
22-28	108	48.4	166	62.9
29-32	0	0.0	12	4.5
Total	223		264	

Table 3. Means of remaining teeth in 1968 and 1980 in the longitudinal and cohort studies.

Actual age	1968 Mean	Actual age	1980 Mean	Diff 1968-80
Longitudinal study				
38	23.9	50	22.2	-1.7
46	21.0	58	19.0	-2.0
50	19.7	62	17.7	-2.0
54	19.6	66	17.2	-2.4
60	16.9	72	13.6	-3.3
Cohort study				
38	23.2	38	25.3	+2.1
50	19.7	50	22.2	+2.5

Table 5. Means of bonescore values in the longitudinal and cohort studies. Mean differences between 1968 and 1980.

Actual age	1968 Mean	Actual age	1980 Mean	Diff 1968-80
Longitudinal study				
38	0.62	50	0.83	+0.21
46	0.85	58	1.00	+0.15
50	0.89	62	1.05	+0.16
54	0.96	66	1.04	+0.08
60	1.10	72	1.18	+0.08
Cohort study				
38	0.66	38	0.56	-0.10
50	0.89	50	0.83	-0.06

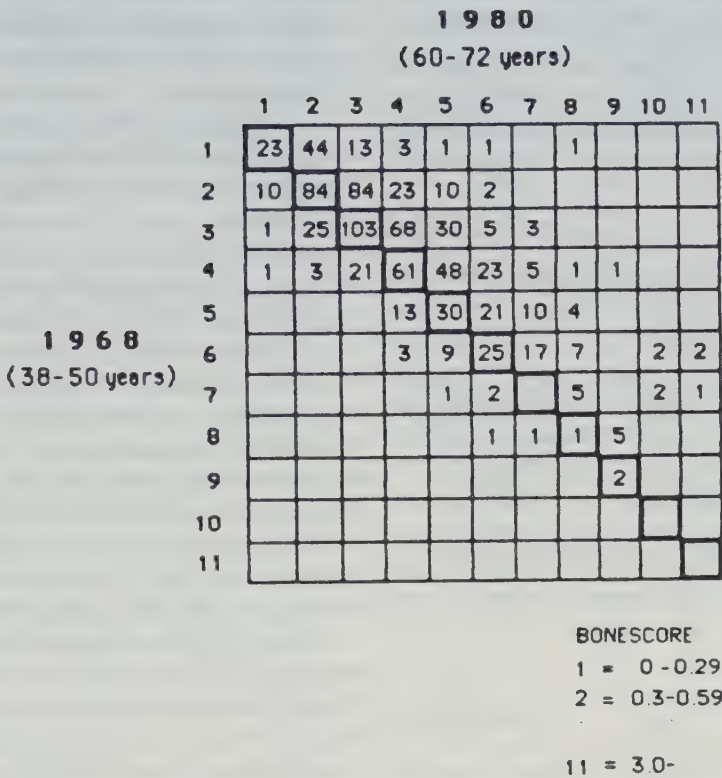


Fig. 2. Distribution of mean bone scores for women 38/50-60/72 years of age as found in 1968 and 1980.

0.01) and had increased in all age groups during the interval. This increment varied from 0.21 in the youngest to 0.08 in the oldest groups.

The distribution of mean periodontal bone heights as found in 1968 and 1980 in the longitudinal study for all age groups is shown in Fig. 2. The progression during the 12 year interval seemed not to be related to the initial status. Table 6 gives a closer view of the progression in the different age groups. The frequencies are grouped in 5 intervals. The first one represents groups with no or limited changes. The limit ≥ 0.9 was chosen to illustrate a progression of a more severe character, i.e. loss of around one fourth of the optimal bone height. About 83 per cent had a mean bone score value of the same magnitude at

both occasions while about 5 per cent showed a considerable progression. The number of individuals showing greater bone loss was lowest in the 50/62 year old group.

Table 6. Percentage of individuals in relation to changes of mean bonescore values in the 12 year longitudinal study.

Age		Changes of bonescores				
1968/80	n	≤ 0.3	0.6	0.9	1.2	≥ 1.5
38/50	264	80.7	12.1	4.9	1.1	1.1
46/58	258	80.6	15.9	3.1	0.0	0.4
50/62	223	88.7	7.6	1.3	2.2	0.0
54/66	94	78.8	13.8	5.3	1.1	1.1
60/72	23	82.6	13.0	0.0	4.3	0.0
Total	862	82.7	12.3	3.4	1.2	0.6

Table 7a. Distribution of mean bonescore values of 38 year old women in 1968 (n = 340) and 1980 (n = 107) in the cohort study.

Bone-score	1968		1980	
	n	%	n	%
0 < 0.6	165	48.6	70	65.4
0.6 < 1.2	141	41.5	31	28.9
1.2 < 2.1	32	9.4	6	5.6
2.1 < 2.7	2	0.6	0	0.0
Mean	0.66		0.56	

Table 7b. Distribution of mean bonescore values of 50 year old women in 1968 (n = 223) and 1980 (n = 264) in the cohort study.

Bone-score	1968		1980	
	n	%	n	%
0 < 0.6	52	23.3	84	31.9
0.6 < 1.2	107	48.0	122	46.2
1.2 < 2.1	58	26.0	52	19.7
2.1 < 2.7	6	2.7	4	1.5
2.7 -	0	0.0	2	0.8
Mean	0.89		0.83	

The bonescore values in the two cross-sectional cohorts were studied by analysing the frequency distributions (Table 7a and b). There was a significant difference in the distributions in 1968 and 1980, respectively, in the 38 year old women. More than 65 per cent of the women had only slight bone loss in 1980 compared to 49 per cent in 1968 ($p < 0.01$). In the 50 year cohort no significant differences were found for the distributions in 1968 and 1980. Thirty-two per cent of the women showed a slight bone loss in 1980 compared to 23 per cent in 1968 ($p < 0.05$).

DISCUSSION

Our knowledge is poor about the differences between individuals of different ages as regards the severity and specially the progression of periodontitis.

The present study was made to add some new facts concerning these matters. The

sampling method was chosen in order to minimize the variability associated with the age factor by choosing individuals born at specific ages.

The dropping-out was presumably only to a small degree caused by odontological conditions since the study was part of a medical investigation.

Extractions as a therapeutical method have decreased dramatically in Sweden during the last decade (Sundberg & Öwall 1984). Whether or not this is a result of an improved dental health or a reflection of changing attitudes of the dentists as well as of the patients is still not clarified. In this study on an average only two teeth were extracted per individual during the observed 12 year period in age group under 60. It is apparent from the number of remaining teeth in 1968 that the earlier extraction rate had been considerably higher.

The periodontal status as well as the progression of the disease was studied with panoramic radiography, a technique which is well fitted for mass screening in epidemiological research since it is comfortable for the participants and renders good possibilities to evaluate dental conditions (Björn & Holmberg 1966, Ahlqwist *et al.* 1986).

In Sweden longitudinal epidemiological studies by means of roentgenograms have been used by Björn (1974) in a 6-year study of male staff members of a shipbuilding yard in Malmö and by Lavstedt *et al.* (1982) in a 10-year study of a randomized sample of inhabitants in the county of Stockholm.

Mean bonescore values calculated on remaining teeth cannot be directly applied to the whole dentition. The progression rate calculated on the difference between consecutive mean values is further affected by extractions during the observed period. This effect will be more pronounced from 40 years and up since extracted teeth in these ages commonly have a greater bone loss than the rest of the dentition (Björn 1974). Thus the progression of periodontitis most likely is to a certain extent underestimated in the pre-

sent study. Another confounding factor is that indications for extraction are not the same in different socio-economic and different age groups. This obstructs the possibilities to compare the severity as well as the progression of marginal bone loss (Anderson 1974). There problems will be further discussed in a later report (Halling & Björn 1986). The present study confirms the data from Lavstedt *et al.* (1982) in showing that progression of marginal bone loss after a lapse of 12 and 10 year respectively is very limited for the great majority of individuals. To make a comparison possible the 0.1 bone score value in this study can be translated to approximately 2.5 per cent of the total root length. This means that 82.7 per cent had a progression less than 7.5 per cent of the tooth length compared to 81.4 in the study by Lavstedt *et al.* The mean progression rates in comparable age groups seem however to be somewhat lower in this study which may be due to differences in the method used for bone height measurements. Furthermore the progression in this study is neither correlated to bone score values at the first examination nor to age in contrast to results reported by Lavstedt *et al.* To what extent these findings are due to extractions of periodontally affected teeth will be analysed in detail in a later report (Halling & Björn 1986).

In 1980 the 38 as well as the 50 year old women had on an average more remaining teeth than corresponding age groups in 1968. Loss of molars has been the most important reason for the reduction of the dentition. Thus it is notable that in the present study the number of individuals having at least two molars left was 17–19 per cent higher in the 1980 cohorts than in those 12 years earlier.

The result may reflect the changed attitude towards extractions as an alternative therapy even in molar regions. In the 38 year cohort the higher number of remaining teeth may further be due to healthier periodontally conditions. In 1980 only 34.5 per cent had an average reduction of marginal bone loss ex-

ceeding 15 per cent of the total root length compared to 52.5 per cent in 1968. In the 50 year old women, however, there was no significant difference between the two cohorts in this respect.

CONCLUSIONS

The main result from the prospective study was that the majority of the women on an average had a rather insignificant marginal bone loss during the 12 year observation period. However, five per cent showed a considerable progression.

The results from the cross-sectional study of the 38 and 50 year old cohorts revealed a clear improvement of the dental state between 1968 to 1980 as far as tooth loss and loss of alveolar bone concerns.

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Paper Y

Periodontal status in relation to education and dental attendance

A 12 year longitudinal and a cross-sectional study of a random sample of dentate middle-aged women in Gothenburg

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Key words: Epidemiology, alveolar bone height, radiographic assessment, tooth loss, longitudinal study, cross-sectional study, education, dental attendance.

ABSTRACT

The periodontal status was studied in one longitudinal (1968–1980) and one cross-sectional investigation on samples from an urban population of women, 38–60 years of age. The status was described by the number of remaining teeth and the proximal alveolar bone height assessed by measurements in panoramic radiographs. The periodontal condition was related to educational level (1–3) and time elapsed since last visit to a dentist.

Longitudinal study: About 65 per cent of the women had no higher education than primary school. In all age groups women on the lowest educational level had significantly fewer remaining teeth than those in higher educational groups. During the 12-year observation period on an average, 1.7–2.0 teeth were lost irrespective of educational level. There were no differences of mean bone heights between the educational groups either in 1968 or 1980. However, in the two lowest ones about 7 per cent, compared to less than 5 per cent of the women with a higher education, had experienced periodontal breakdown corresponding to approximately one fourth of the total root length.

Sixty-nine per cent of the women had visited their dentists within the last year and 17 per cent had paid a visit more than two years ago. In all age and educational groups the most recent visitors had more remaining teeth and had on an average lost fewer teeth during the 12 year period than the others (1.7 compared to 2.3–2.6 teeth). The mean bone levels were significantly higher, both in 1968 and 1980, and the percentages of women showing pronounced breakdown of alveolar bone during the observation period was significantly lower among the most recent visitors.

Cross-sectional study: The investigation included two cohorts, the one comprising 38 year and the other 50 year old women. Sixty-seven per cent of the women in the 38-year cohort from 1968 had passed only primary school compared to 34 per cent of the women of the same age in 1980. A corresponding difference was not found in the 50-year cohorts, of which 66 per cent both in 1968 and 1980 had only primary school education. The women in both cohorts had significantly more remaining teeth and more periodontal bone support in 1980 than in the same age groups in 1968.

SAMMANFATTNING

I en longitudinell och en tvärsnittsstudie i samples ur en population storstadskvinnor i åldrarna 38–60 år studerades parodontalstatus med avseende på antal kvarvarande tänder och parodon-

tal benhöjd. Resultaten sattes i relation till utbildningsnivå (1-3) och till den tid som förflutit sedan senaste tandläkarbesöket.

Longitudinella studien: Ca 65% av kvinnorna i den longitudinella studien hade endast folkskola som bakgrund. Kvinnorna i de lägsta utbildningsgrupperna hade i alla åldrar signifikant färre kvarvarande tänder än kvinnor med högre utbildning. I genomsnitt förlorades 1,7, 2,3 och 2,0 tänder i utbildningsgrupperna 1-3 under observationsperioden. Inga skillnader kunde konstateras i parodontal benhöjd mellan kvinnor på motsvarande utbildningsnivå vid jämförelse såväl 1968 som 1980. Under den 12-åriga observationsperioden kunde en påtaglig reduktion, motsvarande ca en fjärdedel av rotlängden, konstateras i 6,8, 7,5 och 4,8% hos kvinnorna i utbildningsgrupperna 1-3.

Sextionio procent uppgav vid det första undersökningstillfället att de hade besökt tandläkare under det senaste året. Signifikanta skillnader med avseende på antal kvarvarande tänder kunde konstateras i alla åldrar mellan de olika besöksgrupperna. Under observationsperioden förlorades i medeltal 1,7 tänder hos dem som uppgivit att de besökt tandläkare senaste året jämfört med 2,3-2,6 tänder hos de övriga. Andelen kvinnor som uppvisade en parodontitprogression under observationsperioden motsvarande ca en fjärdedel av rotlängden var lägre hos dem som uppgivit besök hos tandläkare senaste året.

Tvärsnittsstudien: I undersökningen ingick två kohorter, en bestående av 38-åriga och en av 50-åriga kvinnor. Sextiosju procent av 38-åringarna 1968 hade endast genomgått folkskola jämfört med 34% av kvinnorna i 1980 års kohort. Motsvarande andel av 50-åringarna var ca 66% i båda kohorterna.

Såväl 38 som 50-åringarna hade signifikant flera tänder och mer parodontalt benstöd 1980 än 1968.

INTRODUCTION

Earlier studies (*Smedby et al.* 1972, *Håkansson* 1978, *Ulf* no 49, 1986), have shown that, on a populational level, the state of dental health is closely related to the level of education.

To our knowledge no study has been focused on women with regard to this factor. One of the most important grounds may be that higher education in earlier days was relatively rare among women also in Sweden. During the last few decades a radical change has occurred resulting in a dramatic increase of the proportion in the younger age groups of women with a high education. However, when the present investigation started still a substantial part of the middle-aged and older women had only passed primary school. These facts prompted a study of the progression of dental diseases in relation to age, educational level and dental care habits. The realization of this idea was made possible by the fact that a comprehensive study of the general health state of middle-aged women was planned in Gothenburg and subsequently staged during the years 1968-1980 (*Bengtsson et al.* 1973). The opportunity to add a dental health investigation was seized.

AIM

The aim of this investigation was to find out by one longitudinal and one cross-sectional study of urban women 38-60 years of age if the level of education and/or the time elapsed since last visit to a dentist had had any influence on the periodontal bone height and the progression of alveolar bone breakdown.

MATERIAL

The study included dental health examinations carried out in 1968 and in 1980, respectively, i.e. with a 12 year interval, on age stratified samples of women who initially were 38 to 60 years of age. Details about sampling technique, participation and dropping-out have been given elsewhere (*Bengtsson et al.* 1973, *Halling & Bengtsson* 1981, *Halling & Björn* 1986). Only dentate women were included in the study.

LONGITUDINAL COHORT STUDY

The studied cohort comprised 864 individuals living in Gothenburg in 1968 as well as in 1980. The samples were stratified on the ages of 38, 46, 50, 54, and 60 years.

CROSS-SECTIONAL COHORT STUDIES

Two cohorts in age groups 38 and 50 years were studied in 1968 as well as in 1980.

The 38 year old cohorts comprised

- 338 individuals in 1968 and in 1980 a cohort comprising 106 new participants.

The 50 year old women were identical with those in the longitudinal study, i.e.

- 222 in 1968 and 263 in 1980.

METHODS

In 1968 the dental health examination was carried out at the Sahlgren Hospital and in 1980 at the department of Oral Radiology, University of Gothenburg. The dental status was recorded by orthopantomography (*Paa-tero* 1960). The technical work was throughout the study in 1968 performed by one specially trained dental assistant and in 1980 by personnel at the department of Oral Radiology. Each one of these investigations were carried out within a one year period.

Information on the level of education was obtained by means of questionnaires in connection with the main medical study in 1968. The educational levels were identified as

- 1. Primary school.
- 2. Uncompleted secondary school, secondary school certificate.
- 3. Higher education, academic studies.

The questionnaires included information about dental attendance which was used in restricted parts of the present study. The question asked was: "When did you last go to see a dentist?"

The alternatives were:

- Visit group 1. Within the last year.
- 2. More than one and less than two years ago.
- 3. Two or more years ago.

The interproximal bone heights were determined on roentgenograms by means of a plastic ruler according to a method described by *Björns & Holmberg* 1966. One interval on the scale corresponds to approximately one fourth of the total root length. All radiographs in 1968 as well as in 1980 were examined by one of the authors (A.H.). The reliability of the measurements was assessed by *Halling & Björn* 1986. The mean bone score (BSC) for each individual was determined as the arithmetic mean of all measurable bone heights in the dentition.

STATISTICAL METHODS

Conventional methods were used for calculating mean values (mean) and standard deviations (s.d.). The significance of differences between arithmetic means was tested by Student's t-test (two-tailed for bone score values and one-tailed for extracted teeth), while that of differences between medians was tested by the two-tailed Mann-Whitney U-test. Chi-square tests were applied for assessing the significance of differences in distribution of numbers of individuals. The null-hypothesis was rejected at $p < 0.05$.

RESULTS

LONGITUDINAL STUDY

The distribution of participants on age strata and education is illustrated in Table 1. About

Table 1. Distributions of participants in the longitudinal study on age and level of education.

Real age		Level of education			Described as
1968	1980	1	2	3	
38	50	173	65	25	38/50
46	58	162	65	32	46/58
50	62	147	49	28	50/62
54	66	63	19	12	54/66
60	72	18	2	4	60/72
38-60	50-72	563	200	101	

65 per cent of the women in the longitudinal cohorts had no higher education than primary school. Due to the small size of the samples in educational groups 2 and 3 in the oldest age group, only the women belonging to educational group 1 were subjected to analysis.

Number of teeth – educational level

Table 2 presents the mean numbers and standard deviations of remaining teeth in 1968 and 1980 in relation to educational levels for

different age strata. In all age groups the women with the lowest education had significantly fewer remaining teeth than those in the higher educational groups. For the 1980 sample the differences were verified at the 0,1% level. The differences increased by increasing age from 2.9 to 6.8 teeth.

Mean numbers of teeth lost during the 12-year interval as well as the distributions of individuals on the number of lost teeth are illustrated by Fig. 1. Due to small samples the

Table 2. Number of remaining teeth. Means and standard deviations (S.D.).

Age	Level of education	n	1968		1980	
			Mean	S.D.	Mean	S.D.
38/50	1	173	23.2	4.99	21.6	6.17
	2	65	25.6	3.32	23.4	4.55
	3	25	25.8	4.60	24.5	6.01
46/58	1	160	19.3	6.52	17.3	6.94
	2	65	23.2	4.97	21.7	5.69
	3	32	25.0	3.20	22.4	5.68
50/62	1	145	18.0	6.20	16.1	6.57
	2	49	22.2	5.11	20.0	6.27
	3	28	23.7	5.81	21.7	6.10
54/66	1	63	18.2	6.24	15.9	7.16
	2	19	21.3	5.39	18.4	7.43
	3	12	24.7	2.64	22.7	3.45
60/72	1	17	15.6	6.04	12.4	7.04

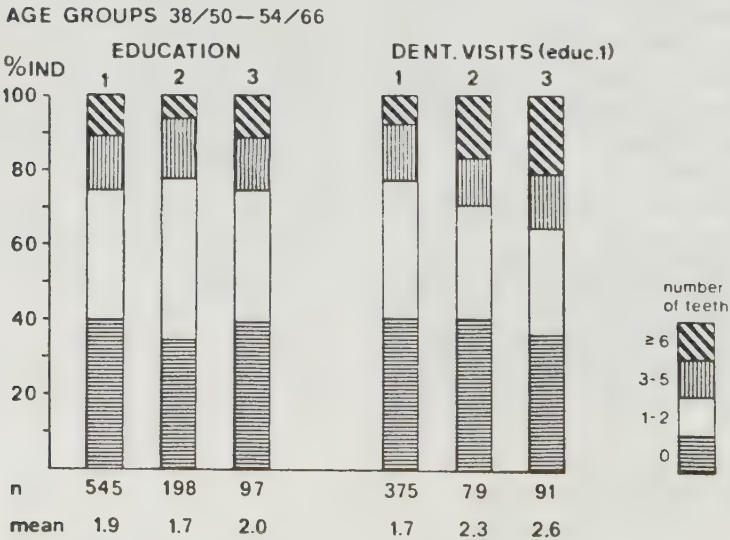


Fig. 1. Teeth lost 1968–1980.

oldest age group is excluded not to interfere with the possibility of comparisons between the different educational groups. On an average 1.7–2.0 teeth were lost during the 12 years. There was no significant difference between the educational groups either in this respect or concerning the distribution of individuals on different latitudes of number of extracted teeth. The range of lost teeth within each separate age group varied from 1.3 to 2.9 but with one exception the differences were not statistically significant. In the oldest group (60/72), however, on an average 3.2 teeth were lost, which is significantly more than the loss in the other groups (Mann-Whitney, $p < 0.05$).

Bone score – educational level

The distributions in the entire samples of mean bone score values in 1968 and 1980 in

relation to educational levels are depicted in Fig. 2. The mean bone score values are described on three levels: low, medium and high, represented by score values < 0.9 , $0.9 - < 1.8$ and ≥ 1.8 respectively. There were no differences between the groups either concerning distributions or mean bone score values.

The mean values in the different age groups are given in Table 3. In all age groups the bone score means varied independently of the educational level.

Fig. 3 shows the distributions of the differences between 1968 and 1980 of mean bone scores values in relation to educational level in 38/50 to 54/66 year old women. The differences were grouped in 0.3 unit intervals. Pronounced progression, i.e. more than 0.9 units corresponding to approximately one fourth of the root length, had occurred in 2.8, 2.5 and 4.1% of the women in respective educational

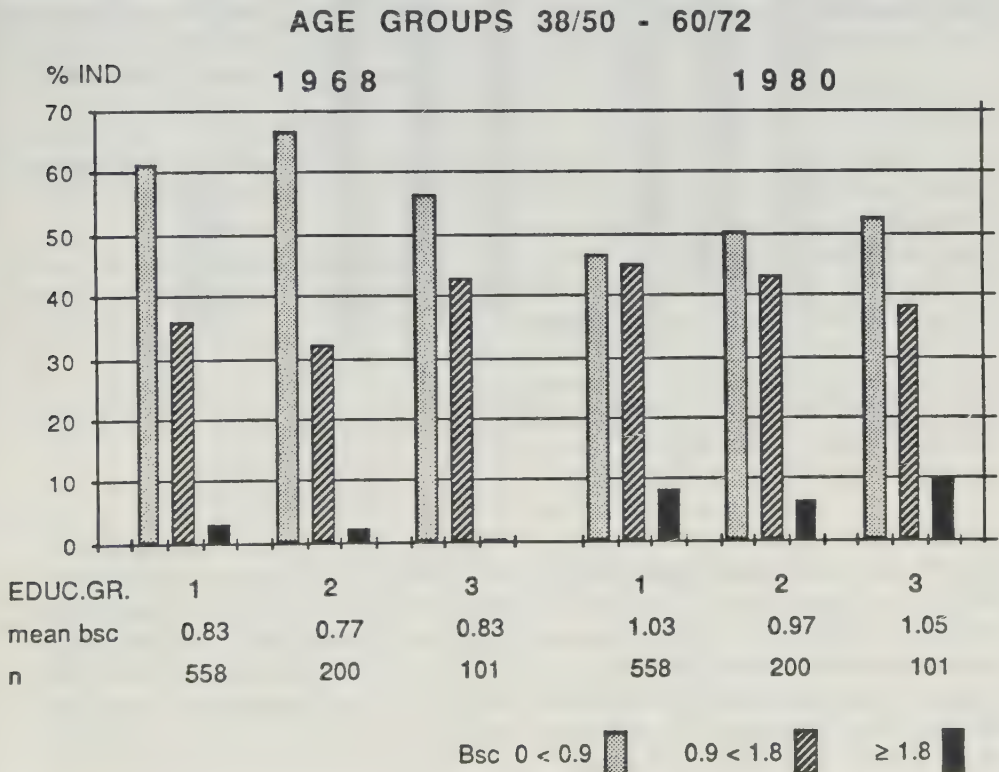


Fig. 2. Distribution of mean bone scores in 1968 and 1980 in the three educational groups.

Table 3. Bone score values. Means and standard deviations (S.D.).

Age	Level of education	1968		1980	
		Mean	S.D.	Mean	S.D.
38/50	1	0.65	0.388	0.90	0.488
	2	0.56	0.294	0.83	0.431
	3	0.64	0.362	0.87	0.597
46/58	1	0.86	0.462	1.05	0.524
	2	0.79	0.418	0.94	0.439
	3	0.84	0.431	1.09	0.534
50/62	1	0.98	0.484	1.11	0.508
	2	0.90	0.445	1.10	0.571
	3	0.87	0.464	1.04	0.632
54/66	1	0.89	0.433	1.11	0.540
	2	1.04	0.395	1.21	0.465
	3	0.96	0.403	1.14	0.398
60/72	1	1.07	0.555	1.12	0.639

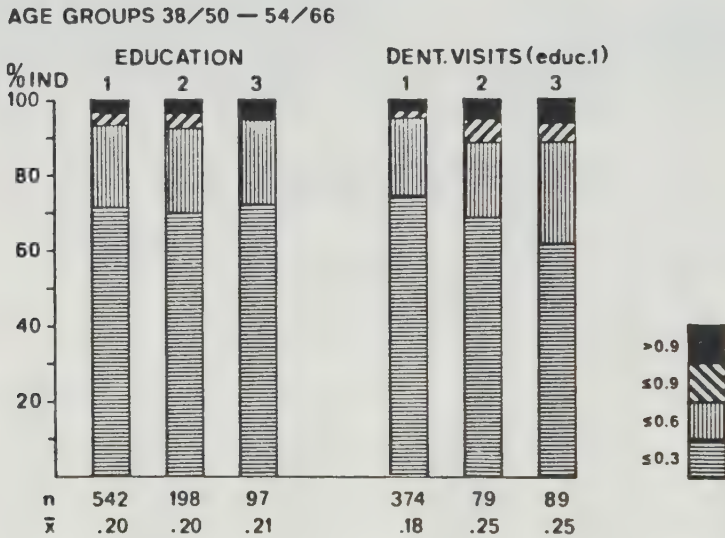


Fig. 3. Differences in bone scores 1968-1980.

group. The mean differences were about 0.2 in all groups and were not statistically significant.

In evaluating the influence of dental attendance on the periodontal status only educational group 1 was considered, due to the small sizes of the other groups. Table 4 shows the distribution of women on "time elapsed

since last visit" in the different age groups. Sixty-nine per cent had attended their dentist within the last year and 17% had paid a visit more than two years ago. The oldest group was not included in the analysis due to the small numbers of participants in the subgroups.

Table 4. Percentual distribution of individuals in relation to dental attendance. Education level I.

Dental attendance	Age				Total
	38/50	46/58	50/62	54/66	
1	76.9	64.2	64.6	68.2	68.8
2	10.4	16.0	16.3	17.5	14.5
3	12.7	19.8	19.0	14.3	16.7
n	173	162	147	63	545

Number of teeth – dental attendance

The distributions of remaining teeth are shown in Table 5. There were significant differences in this respect between the "visit groups" in all ages except among the youngest where this was true only of the difference between "visit groups" 1 and 3. The range of the differences was 3.7–7.8.

Numbers of teeth lost during the observed period are illustrated in Fig. 1. On an average 1.7, 2.3 and 2.6 teeth were extracted in respective group; the differences between "visit group" 1 and the two others are statistically significant. Within the different age groups this significant difference was found only in the youngest group between "visit groups" 1 and 3 (1.4 and 2.9 teeth respectively).

Bone score – dental attendance

The distributions of the mean bone score values in 1968 and in 1980 subgrouped on

Table 5. Number of remaining teeth in 1980 related to dental attendance. Means and standard deviations (S.D.).

Age	Dental attendance	n	Mean	S.D.
38/50	1	133	22.1	5.40
	2	18	21.2	7.89
	3	22	18.4	8.07
46/58	1	104	19.2	5.70
	2	26	15.6	7.42
	3	32	11.4	7.81
50/62	1	95	17.5	6.10
	2	24	15.2	5.78
	3	28	11.2	7.30
54/66	1	43	17.9	6.31
	2	11	11.2	7.19
	3	9	12.0	7.42

dental attendance are shown in Fig. 4. The distributions as well as the mean values differ significantly between group 1 and the two others at both examinations.

A closer view of mean bone score values in 1980 at different ages is given in Table 6. The mean differences between the "visit groups" varied from 0.11 to 0.65 score units, but were significant only between groups 1 and 3 in the two youngest age groups.

Distributions of individuals in the "visit groups" on the changes of mean bone score values are illustrated in Fig. 3. The distributions differ significantly between group 1 and 3 ($p < 0.05$). The mean difference was lowest in "visit group 1" (0.18 compared to 0.25 in the others).

CROSS-SECTIONAL STUDY

The distribution of individuals on the different subgroups in the cross-sectional study is shown in Table 7. In the 38 year cohorts there was a significant difference in distribution on educational levels between the 1968 and 1980 samples ($p < 0.001$). Of those who were 38 years old in 1980, 67% had passed more than primary school compared to only about 34% of those being 38 years in 1968. There were no significant differences in the 50-year cohorts in this respect.

Number of teeth – educational level

Table 8 shows the means and standard deviations of remaining teeth in the cross-sectional study in relation to educational level. In 1980 all subgroups in both cohorts had more teeth left than the corresponding ones in 1968. The

AGE GROUPS 38/50 - 54/66 (educ.gr.1)

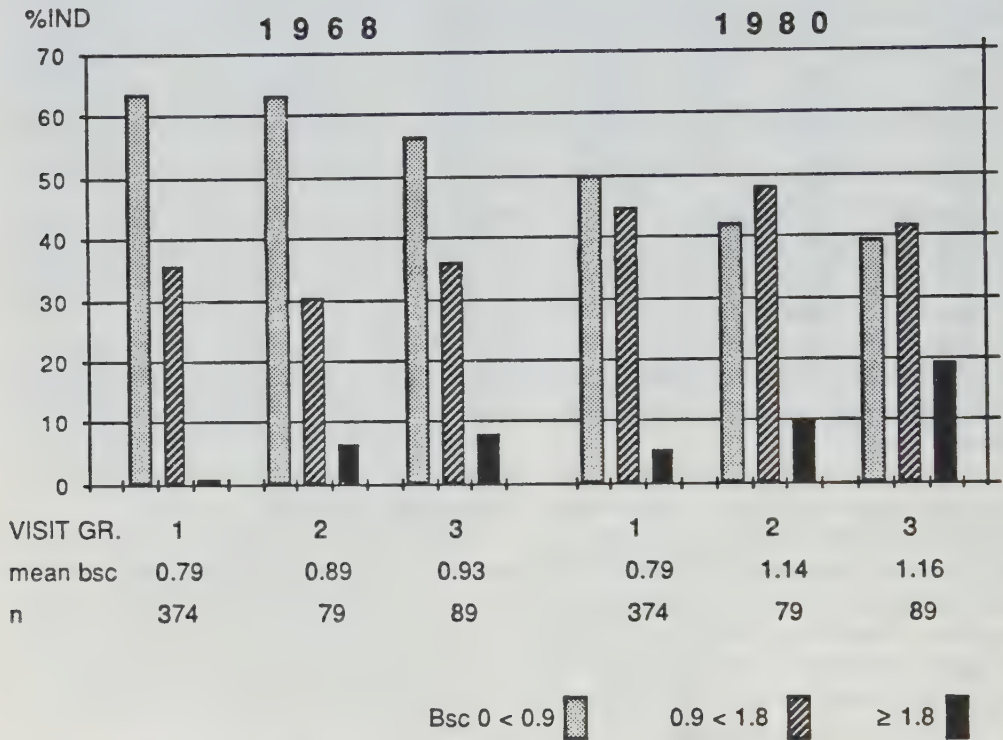


Fig. 4. Distribution of mean bone scores in 1968 and in 1980 in the three "visit groups".

Table 6. Bone score in 1980 in relation to dental attendance. Means and standard deviations (S.D.).

Age	Dental attendance	n	Mean	S.D.
38/50	1	133	0.87	0.481
	2	18	0.89	0.429
	3	22	1.09	0.548
46/58	1	103	0.98	0.472
	2	26	1.18	0.587
	3	31	1.19	0.600
50/62	1	95	1.07	0.449
	2	24	1.18	0.571
	3	27	1.17	0.665
54/66	1	43	1.03	0.414
	2	11	1.36	0.721
	3	9	1.68	0.771

Table 7. Percentual distribution of participants in the cross-sectional studies in relation to level of education.

Real age		Level of education			n
1968	1980	1	2	3	
%					
38	-	65.6	24.6	9.8	337
-	38	33.0	41.5	25.5	106
50	-	65.6	21.9	12.5	224
-	50	65.8	24.7	9.5	263

Table 8. Average number of remaining teeth in 1968 and 1980 in different educational groups.

Age	Level of education	n	1968		n	1980	
			Mean	S.D.		Mean	S.D.
38	1	221	22.4	5.64	35	23.4	6.08
	2	83	24.3	4.83	44	26.0	4.44
	3	33	25.4	4.60	27	27.8	1.93
50	1	147	18.0	6.20	173	21.6	6.17
	2	49	22.2	5.11	65	23.4	4.55
	3	28	23.7	5.81	25	25.8	4.60

differences were statistically significant. The differences in number of remaining teeth between women on different levels of education were larger in 1980 compared to those in 1968 in the 38 year old cohorts.

Bone score - educational level

The distributions of mean bone score values in the 38 year old cohorts in 1968 and 1980 are

depicted in Fig. 5. The corresponding values for the 50 year old cohorts are shown in Fig. 6. The percentages of individuals having mean bone score values less than 0.6 is consistently higher in all groups in 1980. The differences are statistically significant between the entire group and between the lowest educational group in the 38 year old cohort.

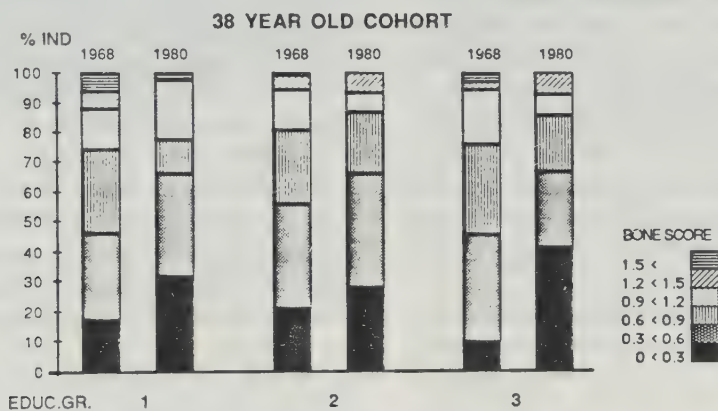


Fig. 5. Distribution of mean bone scores in 1968 and in 1980.

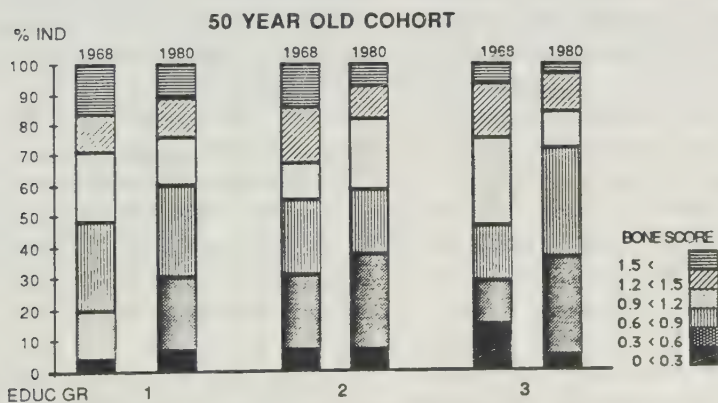


Fig. 6. Distribution of mean bone scores in 1968 and in 1980.

DISCUSSION

The present study was intended to elucidate the influence of educational level and dental care attendance on the periodontal status in a female population. The division into different levels of education is based on the existing educational system during the participating women's adolescence. The choice of educational level is influenced by several factors, among others the availability of schools. In addition, at the actual time, the economic obstacles to further education were insurmountable to the great majority of people in Sweden. This has been of great importance especially for women's possibilities to attend different types of schools. Thus it was not a matter of course for women to join higher education even when intellectual qualifications existed. The consequences may be illustrated by the fact that about 66% of the 50 year old women in 1968 as well as in 1980 only had attended primary school. In the 38 year old cohorts, however, only 33% belonged to the lowest educational group in 1980 compared to 66% of the 38 year old women in 1968. This reflects the changes in the society not only concerning the economical situation but also concerning the importance of education, even for women.

However, these facts must be considered in analyses made on classification based on education in middle aged female populations. Questionnaires and interviews about "time elapsed since latest visit to a dentist" has been used in studies by *Smedby* (1965), *Jensen* (1974), *Gjerme* (1976) and *Nordheim* (1979) and has proved to have a high validity. Groups of individuals stating that they have visited a dentist during the last year may to a great extent be equivalent to regular dental visitors. An answer to a question about the "frequency of visits to a dentist", however, may be influenced by an expected social behavior and thus give an incorrect judgement of the reality. This is one of the reasons for choosing the former type of information in this investigation. In the present study, about 69% of the

women stated that they had visited a dentist during the last year. This is a higher frequency than was found by *Smedby* (1972), *Johansson* (1970) and *Sundberg & Eriksen* (1974). In those studies the corresponding figures varied between 43 and 55%. The difference may partly be explained by the fact that all participants in the present study are women who are known to be more frequent dental visitors than men (*Håkansson* 1978, Ulf no 49, 1986 among others). The frequency of visits is furthermore higher in the big cities than in the rest of the country.

Since there are no comparative studies made exclusively of women the following comparisons are made with studies concerning both sexes or solely males. In the present study a greater number of remaining teeth was found in individuals with higher education which is in agreement with *Björn* (1971), *Anderson et al.* (1974) and *Håkansson* (1978). However, opposite to what was found by *Dunbar et al.* (1968), the number of teeth lost during the observation period did not show any correlation to educational level. The differences observed in 1980 in the number of remaining teeth between women on different educational levels may thus be caused by the differences existing already in 1968.

The results from the cross-sectional study showed that the women in the 38 year as well as in the 50 year old cohort had more remaining teeth in 1980 than the corresponding age groups in 1968. This can be interpreted as an indication of an improved dental health among the adult female population during the last decades.

The average alveolar bone heights were about the same, irrespective of the individual's educational level. This may partly be explained by the differences in the number of remaining teeth between women in the different educational groups. Loss of teeth, especially upper molars and premolars have an influence on the mean bone score values for the whole dentition (*Björn & Halling* 1986b) and may thus conceal existing differences.

Another explanation may, of course, be that the method used was too blunt.

The information about "the latest visit to a dentist" had a more unequivocal correlation to the dental state. Significant differences were found in the number of remaining teeth in those women who more recently had visited their dentists, which is in correspondence with *Björn* (1974), who found less remaining teeth in the sporadic than in the regular visitors. In agreement with the study made by *Björn* (1974), the recent visitors lost less number of teeth during the observed period than the others. The average level of the marginal bone height was higher and the longitudinally observed periodontal breakdown was lower in those women who had had a shorter time elapsed since last visit to the dentist. These observations, however, are in disagreement with those found by *Björn*, and may reflect the fact that dental treatment to day includes periodontal treatment, to a greater extent than earlier.

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VI

Paper VI

**PERIODONTAL BONE HEIGHT IN RELATION TO NUMBER
AND TYPE OF TEETH IN DENTATE MIDDLE AGED WOMEN.
A methodological study.**

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*Key words: Alveolar bone height, radiographic assessment, epidemiology,
abbreviated bone height index.*

ABSTRACT

Assessing the average periodontal bone height of the total dentition in large samples of individuals is a time-consuming and tedious work. The purpose of this investigation was to study the possibility of facilitating epidemiological work by representing the average bone height of the entire dentition by an index based on measurements in limited parts of the dentition. The correlation coefficient, which in several studies has been used as a measure of the agreement between mean bone heights in different regions of the dentition, can not prove any degree of such agreement. Only a comparison of the magnitude of these means can serve this purpose.

Consequently, a first step was a detailed study of the average bone height in different regions of the dentition on a sample of considerable size (862 dentate middle aged women). The proximal bone heights were assessed by measurements in orthopantomograms by means of a five degree plastic ruler (modified Schei ruler, Björn & Holmberg 1966), whereby the bone heights were related to the entire lengths of the teeth.

The results confirmed that the variations in periodontal breakdown between different regions of the dentition are substantial in middle aged populations. The average bone height was lower in the upper than in the lower jaw in all

regions except the incisor areas. In sub-samples of individuals having at least one remaining tooth of each different type (molars, premolars, canines and incisors) in both jaws, the differences in bone heights were smallest and not significant between the means for the mandibular molars and the total means. In subsamples of individuals having lost all mandibular molars, the mean bone score for the combination of mandibular incisors + canines seemed to be the index of choice for representing the total dentition.

SAMMANFATTNING

Att i röntgenbilder mäta de parodontala benhöjderna vid varje tand i bettet är - så snart det gäller ett större antal individer - ett tidsödande och enformigt arbete. Avsikten med föreliggande undersökning var att utreda möjligheterna att underlätta epidemiologiska studier genom att konstruera ett index, baserat på benhöjds-mätningar utförda i begränsade delar av bettet, vilket representerar den genomsnittliga benhöjden.

Korrelationskoefficienten, som i ett flertal undersökningar använts som mått på överensstämmelse mellan medelvärden för olika delar av bettet och bettet i dess helhet kan i själva verket icke visa graden av överensstämmelse mellan medelvärden. Endast en jämförelse av medelvärdenas storlek kan användas för detta ändamål.

Ett första steg var följaktligen en detaljerad studie av de genomsnittliga benhöjderna i bettets olika delar i en större sample (862 tandförsedda medelålders kvinnor). Mätningarna gjordes i ortopantomogram med hjälp av en femgradig skala inristad i en transparent mätsticka modifierad efter Schei 1959 (Björn & Holmberg 1966), varvid benhöjden relaterades till tandens totala längd.

Resultaten visade att den marginala benhöjden varierade påtagligt i olika delar av bettet hos den aktuella gruppen. Den parodontala benförlusten var genomgående större i överkäken i samtliga regioner med undantag för incisivområdena.

Skillnaderna i de genomsnittliga benhöjderna var minst - och icke signifikanta - mellan medelvärdena för underkäkens molarer och bettets totala medelvärden i undergrupper som hade kvar minst en tand av varje typ (molarer, premolarer, caniner och incisiver) i samtliga regioner i båda käkarna. I undergrupper, där varje individ hade förlorat samtliga underkäksmolarer, visade sig medelvärdet för underkäkens incisiv+hörmtandsregioner väl representera den genomsnittliga benhöjden för bettet i dess helhet.

INTRODUCTION

In odontological epidemiological literature periodontal bone heights, measured on roentgenograms, are usually presented as arithmetic means representing either the whole dentition (Björn & Holmberg 1966, Shei et al 1959) or selected teeth or groups of teeth (Björn 1974, Björn, Björn & Halling 1975, Bolin 1986).

It is a well known fact that the rate of progression of periodontitis is different in different parts of the dentition. This rate seems, among other things, to be dependent on the anatomy of the roots and, therefore, higher in the molar-premolar areas especially of the maxilla. Since periodontitis is one of the most common causes of extractions in adult populations (e.g. Cahen 1985), loss of teeth is frequent in the posterior parts of the dentition. As a consequence, bone height measurements presented as arithmetic means, to a considerable extent derive from those parts of the dentition which have the highest resistance to marginal bone loss. Thus the result may be an underestimation of the actual degree of periodontal disease (Shei et al 1959, Grewe et al 1966, Björn 1974, and Axelsson et al 1975, Håkansson 1978).

The appropriateness of using mean values as a basis for comparison of the periodontal status between samples heterogeneous in number of remaining teeth has been questioned. These objections are of special interest at the analysis of age groups from 40 years and up, where heterogeneity of this kind may be considerable.

AIM

The aim of the present study is

1. to elucidate the influence of the average bone height in different regions of the dentition on the mean bone score for the whole dentition;
2. to elucidate the influence of different numbers of remaining teeth on the composition of the dentition with respect to the different types of teeth (incisors, canines, premolars and molars) or regions comprising these teeth;
3. to study the possibility of representing the average bone height of the entire dentition (= the general periodontal bone height) in adult populations by means of bone height measurements in limited parts of the dentition.

MATERIAL

The material analyzed in this study was obtained as age stratified samples from the female population of Gothenburg, Sweden. These samples were examined in 1968 and in 1980, i.e. with a 12 year interval. The age strata of the participating groups were initially 38, 46, 50, 54 and 60 years of age. In the present study only dentate individuals living in Gothenburg at both examinations were taken in consideration, in all 862 individuals.

Details about sampling technique, selection, participation and dropping- out have been given elsewhere (Bengtsson et al 1973, Halling & Bengtsson 1981, Halling & Björn 1986a).

The data discussed in the present study is based on orthopantomographs from 1968. (Data based on the investigation in 1980 will be reported in connection with a study on the progression of periodontal bone loss in different parts of the dentition.)

The total sample of 862 dentate individuals was divided in the following subgroups

- ◇ subjects having at least one remaining tooth of each type (molars, premolars, canines and incisors) in each jaw.
- ◇ subjects having lost all teeth of at least one of these types of teeth, in at least one of the jaws.

The material was further classified in relation to number of remaining teeth in the following subgroups:

- ◇ 1-12 teeth
- ◇ 13-24 teeth
- ◇ ≥ 25 teeth

METHODS

In 1968 orthopantomograms were obtained from all participants. The technical roentgen work was carried out at the Sahlgren Hospital by a specially trained dental assistant and was finished within one year.

The analysis of the orthopantomograms was performed by one of the authors who has had a long experience of this kind of work (A.H.).

The roentgenological evaluation concerned classification and recording of lost

and remaining teeth as well as assessment and recording of the height of the periodontal bone approximal to each remaining tooth.

Numbers of remaining teeth given below were based on the 32-teeth dentition. The different types of teeth (molars, premolars, canines and incisors) in upper and lower jaws were recorded separately.

The interproximal bone heights expressed as "bone scores" was determined according to a method described by Björn & Holmberg 1966. Further details of this method have been given elsewhere (Halling & Björn 1986). Means of bone heights for each individual were calculated as arithmetic means of all measurable bone heights for different types of teeth in the upper and lower jaws as well as for the whole dentition.

In search of a suitable abbreviated index for the general periodontal bone height, averages were calculated for each region of the dentition (as defined above) and for different combinations of regions in upper and lower jaws respectively as well as for different combinations with regard to

- ◇ the number of individuals having remaining teeth in the different regions of the dentition.
- ◇ the relation between bone scores at different types of teeth and those of the whole dentition.

STATISTICAL METHODS.

Conventional methods were used for calculating mean values (mean) and standard deviations (SD). The significance of differences between arithmetic means was tested by Student's t-test (two-tailed), between medians by the two-tailed Mann-Whitney U-test. Chi-square tests were applied for assessing the significance of differences in distribution of numbers of individuals. The null-hypothesis was rejected at $p < 0.05$.

RESULTS

The distribution of individuals according to the composition of the dentition, i.e. presence of different types of teeth, gave rise to the following subgroups.

- ◇ Individuals who had at least one tooth left of each one of the different types of teeth, i.e. at least one molar, one premolar, one canine and one incisor in each jaw; 603 persons, called the "603 sample".
- ◇ Individuals who were edentulous in at least one of these regions in at least one of the jaws; 259 persons, the "259 sample".

The distributions of individuals on the number of remaining teeth in these two groups and in the total sample of 862 individuals are presented in Table 1. The limits set for the ranges of the number of present teeth gave the result, that all individuals in the 603 sample were found to have more than 12 teeth and that all the individuals in the 259 sample had less than 25 teeth.

Table 2 presents the means and standard deviations of the numbers of remaining teeth. The mean values for the total sample and for the 603 and 259 samples were 21.3, 24.3 and 14.2 teeth respectively.

The mean numbers of the different types of teeth in the upper and lower jaw (calculated on individuals dentate in the actual region) are shown in Fig 1. On an average more than half of the original number of molars were lost in both jaws, while nearly all mandibular incisors and canines remained.

The percentages of individuals representing these means are depicted in Fig 2. In the 259 sample, only 19 % of the individuals proved to be the base for the calculations of the number of remaining lower molars. On the other hand, more than 98 % of the individuals had remaining mandibular canines.

The measurability of the bone heights in the different regions is illustrated in Table 3. Mandibular molars and premolars showed on an average the highest measurability, 93 and 81 per cent respectively, while only 48 and 42 per cent of the corresponding maxillary teeth were possible to quantify.

The distributions of mean bone score values for the whole dentition on the number of remaining teeth are described in Table 4. There were significant differences of the mean values: The mean value in the 259 sample was 1.01 compared to 0.73 in the 603 sample ($p < 0.001$). Moreover, there was a significant difference in mean values between these two samples concerning individuals having 13-24 remaining teeth, 0.84 and 1.02 respectively ($p < 0.001$). In all groups, individuals with less remaining teeth showed higher score values ($p < 0.05$; < 0.001), i.e a more advanced periodontal bone loss, with exception of the individuals of the 259 sample.

Fig. 3 presents the distributions of mean bone scores in the different regions in the 603 and 259 samples. The distributions of the means showed a similar pattern in the two samples, with the highest scores in maxillary molar areas and the lowest in mandibular premolar and canine ones.

Fig. 4 gives a view of the mean scores at different types of teeth in groups with different numbers of remaining teeth. The means were consistently lower for all

the different types of teeth in groups with the highest number of remaining teeth. The group with 13 - 24 remaining teeth included individuals from the 603 as well as from the 259 samples. An analysis of the differences in bone score values between these two groups, showed that the values were significantly higher for all the different types of teeth in the 259 sample. ($0.0005 > p < 0.05$) (Table 5). To describe the relation between the means for the different types of teeth and those for the whole dentition, the quotients between these means are given in Fig 5. Mandibular molars showed the best congruence with the whole dentition in all three samples.

Table 6 shows the means for the different regions as well as those for the whole dentition for the 603 sample divided on different age groups. The differences are smallest and not significant between the means for the mandibular molars and the total means in all subgroups.

Since the number of individuals having mandibular molars is strongly decreased in groups with reduced dentitions, calculations were made to find more suitable teeth or combination of teeth with averages as close as possible to the mean for the whole dentition. Only mandibular teeth were found acceptable for this purpose, since on an average about 50 percent of the individuals had lost all teeth in at least one maxillary region (Fig 2). Therefore, calculations with different combinations of mandibular teeth were made on individuals lacking any mandibular molars, i. e. 209 individuals (259 minus 50).

The results are presented in Table 7. The smallest differences were found by combining means for the mandibular incisors with either those for mandibular premolars or those for mandibular canines. Since 98 per cent of the individuals had remaining canines compared to 88 per cent having premolars, the combination of mandibular incisor+canine regions may be the area of choice to represent the whole dentition.

DISCUSSION

The material that has been analyzed in the present study comprises samples which in many respects are homogeneous. They derive from a random selection of middle aged women from an urban population. In two previous investigations (Halling and Björn 1986 a & b), as in the present one, the periodontal bone heights within these samples have been recorded in the form of indices based on measurements in orthopantomograms.

The size of bone height values estimated in this way depends

- ◊ firstly on the readability of the orthopantomograms which, if low, may curtail the possibility to perform measurements;
- ◊ secondly on the representativity of bone heights, measured in dentitions with various numbers of remaining teeth in relation to the *real* bone height for the 32-teeth dentition.

In the present study the mean percentages of measurable bone heights was somewhat lower than in other studies of the same type (Mutschelknauss & von von der Ohe 1978; Adrianes et al. 1982; Ahlqwist et al. 1986). The reason may be differences in the roentgenological technique but also the fact that in the present study very stringent criteria were used for acceptance of a surface as measurable. Mandibular molars and premolars showed the highest measurability (93.3 and 81.1 % resp.) which is in agreement with what was found by previous authors (Björn & Holmberg 1966; Björn, Björn & Halling 1975; Adrianes et al. 1982 and Ahlqwist et al. 1986). Maxillary molar-premolar and mandibular incisor areas have a low measurability due to blurring, overlapping of adjacent structures and difficulties to identify the marginal and apical structures (Ainamo & Tammisalo 1967; Gröndahl et al 1971; Adrianes et al. 1982 among others). Since periodontal bone destruction befalls different parts of the jaws to a varying degree, special interest has in the present report been focused on the relation between periodontal bone height and the number and types of remaining teeth. The results confirm that the variations in periodontal breakdown are substantial between different regions of the dentition. The periodontia of all types of maxillary teeth with the exception of the incisors are more severely involved than those of the mandibular ones.

The periodontal breakdown is also considerable in all molar areas, which among other things is reflected in the fact that the teeth within these areas are those first of all to be lost with age. The bone score values within the molar areas, which originally participated with 37,5 % in the mean bone score of the dentition, will with increasing age have a gradually decreasing influence on the level of the general bone height of an individual.

Therefore, the possibilities of describing periodontal bone state with a single index are pretty restricted. Dependent on the strong variation in progression of periodontitis and thereby in the degree of bone destruction between different

Table 1. Distribution of individuals on the number of remaining teeth.

Sample	R e m a i n i n g t e e t h					
	1 - 12		13 - 24		25 -	
	n	%	n	%	n	%
862	93	10.8	473	54.9	296	34.3
603	0	0.0	307	50.9	296	49.1
259	93	35.9	166	64.1	0	0.0

Table 2. Number of remaining teeth. Means and standard deviations (SD).

Sample	R e m a i n i n g t e e t h							
	1 - 12		13 - 24		25 -		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	Range
862	8.1	2.26	20.4	3.03	26.8	1.50	21.3	3-32
603	-	-	21.9	1.94	26.8	1.50	24.3	14-32
259	8.1	2.26	17.6	2.71	-	-	14.2	3-24

Table 3. Percentual measurability in relation to type of tooth in upper and lower jaw.

Sample	M a x i l l a				M a n d i b u l a				tot
	mol	pre	can	inc	mol	pre	can	inc	
862	48.4	41.9	43.8	60.4	93.3	81.1	54.3	44.0	57.3
603	47.4	38.4	39.6	58.9	93.5	80.7	53.2	42.5	56.2
259	52.5	56.3	58.2	65.6	90.2	82.4	56.9	48.0	59.9

Table 4. Bone score values in the total sample and the subgroups. Means and standard deviations (SD).

Sample	1 - 12		13 - 24		25 -		T o t a l	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
862	0.99	0.570	0.90	0.444	0.62	0.348	0.82	0.452
603	-	-	0.84	0.394	0.62	0.348	0.73	0.387
259	0.99	0.570	1.02	0.505	-	-	1.01	0.529

Table 5. Bone heights in different regions of the dentition in subgroups with 13-24 remaining teeth from the 603 and 259 samples.

Sample	Maxilla					Mandibula					tot
	mol	pre	can	inc		mol	pre	can	inc		
603	$\bar{x}$	1.40	1.13	0.53	1.15	0.84	0.44	0.34	0.99		0.84
n=	SD	0.61	0.56	0.59	0.54	0.58	0.44	0.46	0.61		0.39
307	(n)	255	282	255	259	299	305	258	220		307
259	$\bar{x}$	1.65	1.34	0.79	1.37	1.11	0.65	0.56	1.13		1.25
n=	SD	0.69	0.61	0.66	0.60	0.52	0.60	0.61	0.69		0.35
166	(n)	93	129	144	135	31	156	139	120		166

Table 6. Mean bone scores in different parts of the dentition in the 603 sample.

Age	n	Maxilla					Mandibula					tot
		mol	pre	can	inc		mol	pre	can	inc		
38	226	1.14	0.91	0.26	0.88		0.48	0.21	0.15	0.69		0.58
46	181	1.37	1.12	0.43	1.16		0.81	0.39	0.28	0.95		0.79
50	133	1.48	1.15	0.52	1.16		0.88	0.44	0.33	0.94		0.84
54	54	1.48	1.28	0.57	1.18		0.93	0.48	0.36	1.13		0.89
60	9	1.31	1.10	0.55	1.13		0.80	0.50	0.54	1.32		0.89

Table 7. Mean bone scores in different parts of the dentition in the 259 - 50 sample.

Age	n	prem+inc	prem can+inc	can+inc	tot
38	33	0.79	0.72	0.83	0.92
46	59	0.86	0.80	0.93	0.94
50	73	0.90	0.83	0.91	1.07
54	30	0.95	0.82	0.88	0.96
60	14	1.15	1.05	1.16	1.18
TOT	209	0.90	0.82	0.91	1.00

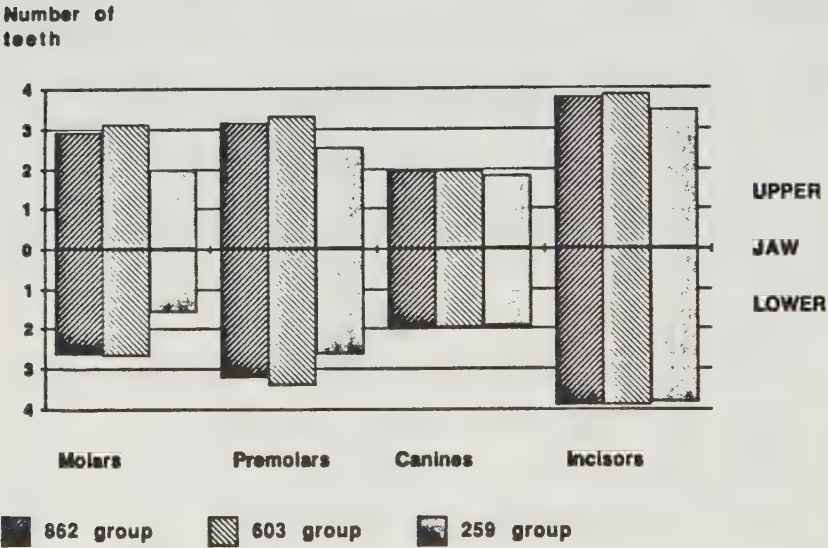


Fig. 1. Number of remaining molars, premolars, canines and incisors in upper and lower jaws respectively.

% IND

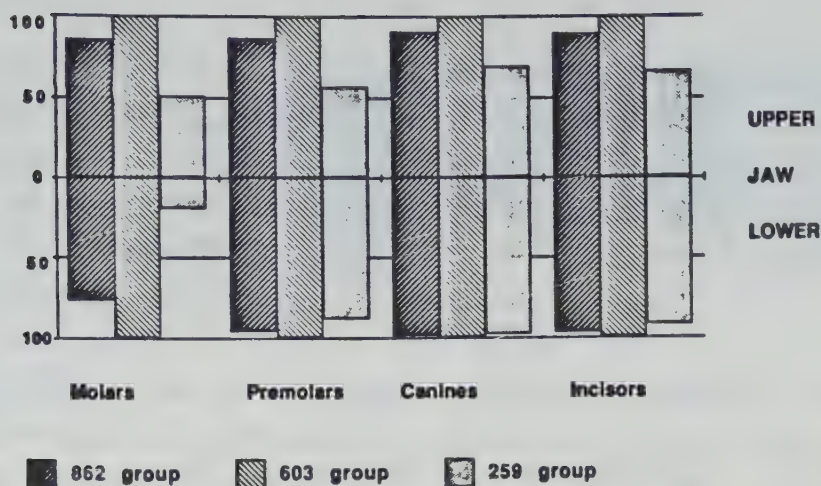


Fig.2. Percentages of individuals having at least one molar, premolar, canine or incisor in the upper or lower jaw respectively.

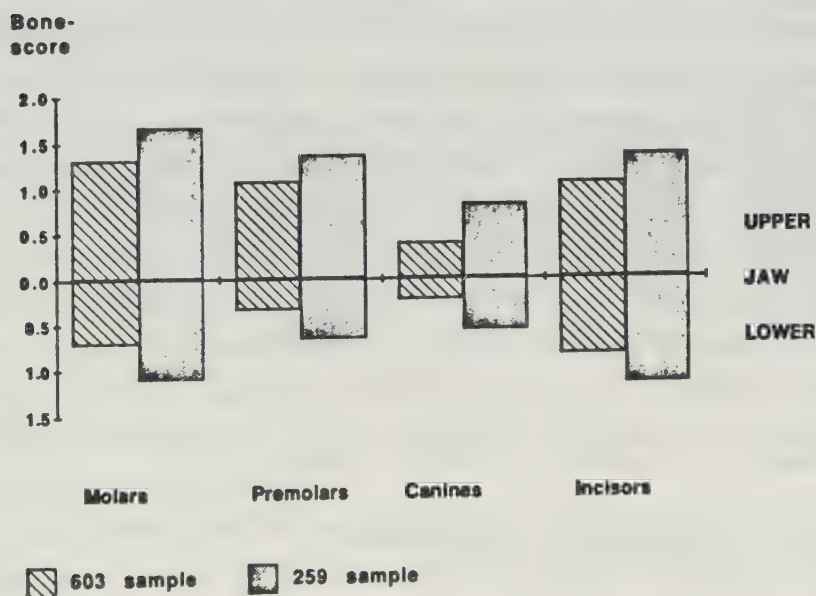


Fig.3. Distribution of mean bone score values for molars, premolars, canines and incisors in upper and lower jaw respectively.

**Bone
score**

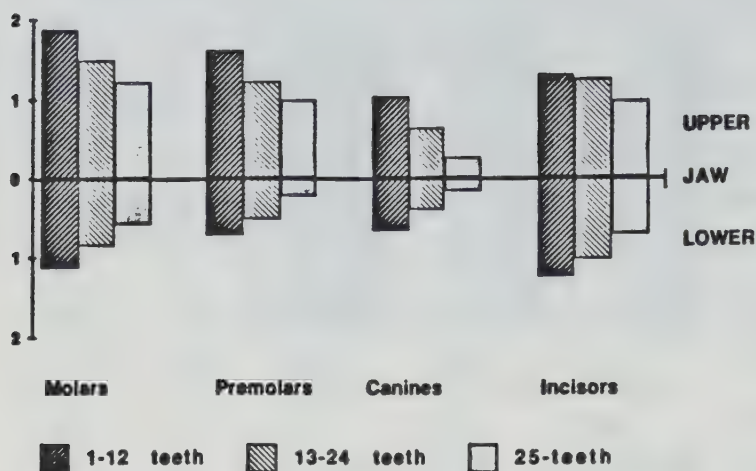


Fig.4. Distribution of mean bone score for molars, premolars, canines and incisors in the subgroups of the 862 sample.

**Bone score
sect/total**

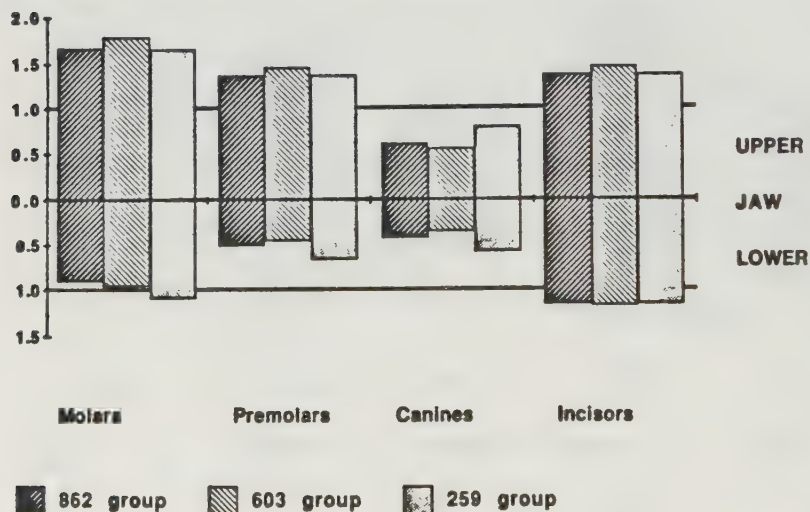


Fig.5. Distribution of the quotients between mean bone score for different types of teeth and those for the whole dentition (region/total).

areas of the dentition, an index of bone loss inevitably will be influenced of the composition of the remaining dentition. This variability has naturally lead to difficulties at attempting to quantify marginal bone heights by a single index for the individual and precautions should be taken especially when studying small samples. (Another factor of importance in this connection is, of course, how well the measuring method expresses the real bone condition.)

Bone height indices - as well as other periodontal indices - differ from other odontological indices principally by being based on direct measurements employing an interval scale. This means that it will be difficult to design an index comprising also maximal damage, i.e. total loss of supporting bone. Therefore, the possibilities to reach a true representation of the actual degree of bone loss by bone height measurements are rather limited.

The numerical values of e.g. the DMF-index denote the number of teeth or tooth surfaces affected or lost by caries. In principle this index is independent of the composition of the dentition with regard to number and type of remaining teeth. Consequently, also missing teeth contribute to the numerical value in this index. Therefore the DMF-index may be said to render a fairly true measure of the general degree of damage, while bone height indices reduce the information to the state within the remaining dentition. A parallel can be drawn with the results obtained when D, M and F are recorded separately. A comparison of the occurrence of filled teeth between groups of individuals with full and such with partial dentitions means in principle that a comparison is made of the occurrence of fillings in the posterior and anterior sections of the dentition, which probably was not the actual intention.

In cross-sectional as well as longitudinal epidemiological investigations it is of course rather important that diseases that shall be studied are described by means of standards that imply the same meaning regardless of the specific composition of the dentition of the separate individual. One way of tackling the problem is to confine comparisons to defined and limited sections of the dentition. This idea is substantiated by several studies (Ramfjord 1959; Björn 1974; Björn, Björn & Halling 1975; Bolin 1986 and others).

The selection of suitable teeth or groups of teeth has usually been based on the degree of correlation between the mean bone height for these on one hand and that for the total remaining dentition. The correlation coefficients observed in the present study varied between 0.64 and 0.78. However, bone heights valid for the teeth or groups of teeth with the highest correlation did not always render the best measure to represent the the mean for the whole remaining dentition, an observation, which of course is important above all for epidemiologic studies. Consequently it is important to stress that, contrary to what has been believed, there is no clear indication to select teeth with the strongest correlation to the rest of the dentition as representing the whole remaining dentition.

It appeared in the subsample which had remaining teeth of all types (the 603 sample) that bone height measurements at the mandibular molars gave the best agreement with the values for the total dentitions.

In the subsample with reduced representation of types of teeth a combination of measurements at mandibular incisors and canines resulted in means that best agreed with those for the total dentition.

From radiation-hygienic points of view availability of an abbreviated index is essential for the possibility to utilize measurements based on roentgenographs in order to compare the degree of bone destruction in different populations. The results obtained are strictly valid only for the sample studied. Similar investigations of other samples are clearly indicated.

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VIII

Paper VII

Key words: Epidemiology; dentistry phobia; prevalence; course; missing teeth; marginal bone loss; dental care habits.

Prevalence of dentistry phobia and its relation to missing teeth, alveolar bone loss and dental care habits in an urban community sample

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ABSTRACT - In a representative sample of 784 women in Gothenburg, aged 38-54 years, the point prevalence of dentistry phobia was 13.4 %; 4.3 % suffered a dentistry phobia of high degree. The prevalence was much increased in women with low school education and in the lower social classes. In most cases (88 %) the phobia onset occurred before age 20. Only 11 % of the phobic subjects were aware of having been exposed to anxiety-provoking dental treatment situations at onset of phobia. All phobics reported a chronic course, although most of them (90 %) had partial remissions at times. Phobia of dental treatment was related to high number of missing teeth, high amount of alveolar bone loss and a high prevalence of removable dentures. Most associations between dentistry phobia and impaired dental status remained statistically significant when allowance was made for age and social class. The neglected dental status in the phobic women may have psychological effects and impair the social functioning. As the incidence peak occurs early in life, preventive measures must primarily be directed against children and adolescents.

Received February 12, 1984; accepted for publication April 28, 1984

There is considerable literature dealing with dental treatment anxiety (for review, see (1)). Reports have shown that anxiety of dental treatment in its most severe

form, dentistry phobia, leads to increased missed or cancelled appointments, irregular visits to the dentist and, as a consequence, deterioration of the teeth (2-8).

However, most of these studies are based on different types of clinical material that are not representative of dental anxiety in the general population. There are only a few community studies of dentistry phobia and in these the validity of the phobia ratings seems questionable. Hence, not much is known of the prevalence rate and course of dental treatment phobia.

In contrast to earlier work, the present study is based on a representative population sample of middle-aged urban women, and the phobia ratings were made by a psychiatrist. Assessments of dental status variables were made from roentgenograms. The aim of the study was to establish the prevalence and clinical characteristics of dentistry phobia and its interrelationships with demographic factors, dental status and dental-care habits.

Study population

A study of a representative systematic sample of women in the age strata 38, 46, 50, 54 and 60 years was performed in 1968–1969 in Gothenburg. 1462 women were examined (participation rate 90.1 %). Further details about the sampling procedure and the participants and nonparticipants in the study have been given elsewhere (9, 10).

A representative subsample of women in four age strata (38, 46, 50 and 54 years) was selected for the psychiatric and the odontological investigation. Eight hundred women (89.0 %) participated in the psychiatric examination. Of these, 775 (86.2 % of selected subsample) also participated in the dental examination. There were slightly more single women among the nonparticipants. There were, however, no significant differences between the participants and nonparticipants re-

garding prevalence of mental disorder and socioeconomic stratification.

It was not possible to assess the phobia degree with any precision due to psychosis or language difficulties in 16 of 800 women (15 of 775). Thus the total number presented in Table 1 is 784 and in Tables 3–4, 760. Further missing data are accounted for in some of the variables.

Methods

Psychiatric examination

A semi-structured psychiatric interview which lasted between 1 and 2 h was performed by T.H. A more detailed account of the psychiatric examination has been given by Hällström (10) and Hällström & Samuelsson (11). During the interview, among others, the following items were covered:

Degree of avoidance was assessed according to how seldom the subjects reported they had visited a dentist. No avoidance behaviour was rated when the anxiety never delayed or prohibited this. Severe avoidance was rated when the subject, because of her anxiety, had refused to see a dentist for several years despite good reasons for doing so. Avoidance of mild or medium degree was rated for grades between these two extremes.

Perceived degree of anxiety before and during dental treatment was rated as mild (no or mild autonomous-vegetative symptoms), medium (moderate autonomous-vegetative symptoms) or severe (intense vegetative symptoms or panic attacks).

Duration of dentistry phobia was assessed since the start in childhood/adolescence (before age 20), from age 20 up to more than 10 years ago, 10 years ago and less.

Course of dentistry phobia was classified in the following groups: episodic recurrent, chronic with partial remissions, chronic with constant intensity, chronic but gradually getting better, chronic and gradually growing worse.

Awareness of having been exposed to especially anxiety-provoking dental treatment situation at start of dentistry phobia: no, yes possibly, yes definitely.

Degree of dentistry phobia. The information about perceived anxiety and avoiding behaviour assessed in the interview was weighted together in a global rating of degree of dental treatment phobia (nil, low, high).

Social class was defined according to husband's or former husband's job for married or previously married women and according to own job for never married women. Classes 1-4 denote upper middle class, lower middle class, skilled workers and unskilled workers, respectively.

School education was assessed according to a seven-degree scale which has been condensed in Table 1 because of very few observations in some of the cells.

Dental examination

For all women a panoramic roentgenogram (12) was taken by a trained dental nurse. The roentgenograms were studied by the same examiner (A.H.) From these, the number of missing teeth were recorded. *Occurrence of removable dentures* was registered in women with full or partial dentures in one or both jaws. Bone score measurements of the alveolar bone height was performed according to the method described by Björn & Holmberg (13). The higher the bone score, the more alveolar bone is missing. Two mean bone score values were calculated:

1) *Bone score total* i.e. mean of all measurable tooth surfaces.

2) *Bone score abbreviated* i.e. mean of the following measurable tooth surfaces: lower canine distal, lower first and second premolar mesial and distal, in all 10 surfaces. The abbreviated bone score was used for the following two reasons: 1) to compensate for the influence of losses of molars and of other teeth which are usually lost first, and 2) to include teeth with a reasonably high degree of measurability.

Before the dental examination the subjects completed a questionnaire which included questions on dental hygiene and treatment habits. *Toothbrushing frequency* was rated as follows: Less than once a day, once a day, twice a day, three times a day or more. *The time since last dental visit* was rated according to the scale in Table 3.

Statistical methods

Pitman's permutation test (14) was used to test the hypotheses of no correlations between degree of dental treatment phobia and dental status/oral hygiene variables when age and social class were kept constant. The results from the subgroups were pooled according to Mantel (15). The differences were considered statistically significant for values $P < 0.05$ (two-tailed test).

Results

The point prevalence rate of dentistry phobia in the studied sample was 105 out of 784 (13.4 %). Of these, 71 women (9.1 % of total) presented a phobia of

Table 1
Prevalence of dentistry phobia by age, schooling and social class

Age, schooling, social class	Degree of dentistry phobia		Total <i>n</i> (%)	Pitman's permutation test
	Low <i>n</i> (%)	High <i>n</i> (%)		
Age (years)				
38 (<i>n</i> = 107)	9 (8.4)	4 (3.7)	13 (12.1)	N.S.
46 (<i>n</i> = 304)	30 (9.9)	13 (4.3)	43 (14.1)	
50 (<i>n</i> = 285)	28 (9.8)	13 (4.6)	41 (14.4)	
54 (<i>n</i> = 88)	4 (4.5)	4 (4.5)	8 (9.0)	
Schooling				
1 ^a (<i>n</i> = 50)	10 (20.0)	6 (12.0)	16 (32.0)	<i>P</i> < 0.01
2 ^b (<i>n</i> = 537)	49 (9.1)	22 (4.1)	71 (13.2)	
3 ^c (<i>n</i> = 71)	4 (5.6)	3 (4.2)	7 (9.9)	
4 ^d (<i>n</i> = 126)	8 (6.3)	3 (2.4)	11 (8.7)	
Social class				
1 (<i>n</i> = 159)	12 (7.5)	1 (0.6)	13 (8.2)	<i>P</i> < 0.01
2 (<i>n</i> = 265)	28 (10.6)	9 (3.4)	37 (14.0)	
3 (<i>n</i> = 205)	22 (10.7)	8 (3.9)	30 (14.6)	
4 (<i>n</i> = 155)	9 (5.8)	16 (10.3)	25 (16.1)	

^a Remedial class and grade repeaters.

^b Primary school.

^c Uncompleted secondary school.

^d Accomplished secondary school and higher.

Table 2
Avoidance and anxiety grade by degree of dentistry phobia

Behaviour	Degree of dentistry phobia		Total <i>n</i> (%)
	Low <i>n</i> (%)	High <i>n</i> (%)	
Avoidance grade			
None	7 (10.1)	1 (2.9)	8 (7.8)
Mild	10 (14.5)	2 (5.9)	12 (11.7)
Medium	52 (75.4)	8 (23.5)	60 (58.3)
Severe	- -	23 (67.6)	23 (22.3)
Total	69 (100)	34 (100)	103 (100)
Anxiety grade			
Mild	2 (2.9)	- -	2 (1.9)
Medium	64 (91.4)	8 (23.5)	72 (69.2)
Severe	4 (5.7)	26 (76.5)	30 (28.8)
Total	70 (100)	34 (100)	104 (100)

Table 3

Dental treatment and hygiene habits by degree of dentistry phobia

Dental treatment and hygiene	Degree of dentistry phobia			Total n (%)
	Nil n (%)	Low n (%)	High n (%)	
Time since last dental visit ^a				
< 12 months	433 (65.3)	33 (47.8)	7 (25.0)	473 (62.2)
12 months-2 years	87 (13.1)	7 (10.1)	4 (14.3)	98 (12.9)
> 2 years	143 (21.6)	29 (42.0)	17 (60.7)	189 (24.9)
Total	663 (100)	69 (100)	28 (100)	760 (100)
Toothbrushing frequency ^b				
Once a day	55 (9.6)	10 (16.4)	- -	65 (10.0)
Twice a day	315 (55.3)	29 (47.5)	17 (81.0)	361 (55.4)
> Twice a day	200 (35.1)	22 (36.1)	4 (19.0)	226 (34.7)
Total	570 (100)	61 (100)	21 (100)	652 (100)

^a Pitman's permutation test (adjusted for age): $P < 0.0001$.Pitman's permutation test (adjusted for age and social class): $P < 0.0001$.^b Pitman's permutation test (adjusted for age): N.S.

Pitman's permutation test (adjusted for age and social class): N.S.

low degree and 34 subjects (4.3 % of total) suffered a dental treatment phobia of high degree.

The prevalence rates show no significant age trend but there is a significant negative correlation between phobia degree and amount of school education (Table 1). There is also a positive relation between phobia degree and low social class. These associations seem to be especially strong for phobias of high degree. In the lowest social class, the risk for dentistry phobia of high degree is 17 times greater than in the highest class.

Table 2 shows the frequency of different grades of avoidance behaviour in phobic subjects with low and high degrees of phobia. This table also presents the distribution of anxiety grades in the phobic situation in women with dental treatment phobia of low and high degree. About two thirds of the women with high degree dental treatment phobia reported severe avoidance and three fourths of the subjects with low degree phobia presented

avoidance behaviour of medium grade. The time elapsed since last dental treatment, as reported during the dental examination, was also significantly higher for phobic women, and especially those with high degree phobia (Table 3). However, the reported frequency of toothbrushing was not related to degree of dental treatment phobia.

Regarding the duration of the phobia, 92 phobic subjects (87.6 % of phobics) reported suffering from it since childhood or adolescence. Six women (5.7 % of phobics) developed their phobia after the age of 20 but more than 10 years ago. Only seven women (6.7 % of phobics) had had dental treatment phobia for 10 years or less. There were no substantial differences between low and high grade phobics regarding duration or course of the phobia. All phobic subjects reported a chronic course of the dental treatment phobia, 94 (90.4 %) with partial remissions at times, and in only four (3.8 %) was the intensity constant during

Table 4
Dental status by degree of dentistry phobia

Dental status	Degree of dentistry phobia			Total
	Nil	Low	High	
No. of missing teeth ^a	(n = 663)	(n = 69)	(n = 28)	(n = 760)
Median	11.5	14.9	18.0	12.0
Mean	14.9	16.5	20.2	15.2
SD	9.5	8.2	8.6	9.4
Bone score total ^b	(n = 501)	(n = 57)	(n = 16)	(n = 574)
Median	0.77	1.13	1.00	0.80
Mean	0.92	1.16	1.10	0.95
SD	0.57	0.68	0.55	0.58
Bone score abbreviated ^c	(n = 556)	(n = 62)	(n = 19)	(n = 637)
Median	0.33	0.54	0.60	0.38
Mean	0.53	0.67	0.51	0.54
SD	0.59	0.62	0.55	0.59
Prevalence of removable dentures ^d	(n = 663)	(n = 69)	(n = 28)	(n = 760)
n	218	32	18	268
%	32.9	46.4	64.3	35.3

^a Pitman's permutation test (adjusted for age): $P < 0.05$.

Pitman's permutation test (adjusted for age and social class): N.S.

^b Pitman's permutation test (adjusted for age): $P < 0.05$.

Pitman's permutation test (adjusted for age and social class): $P < 0.05$.

^c Pitman's permutation test (adjusted for age): N.S.

Pitman's permutation test (adjusted for age and social class): $P < 0.05$.

^d Pitman's permutation test (adjusted for age): $P < 0.01$.

Pitman's permutation test (adjusted for age and social class): $P < 0.01$.

the years. Six women (5.8 %) had enjoyed a gradual lowering of the phobic grade during life. None reported a truly episodic recurrent course or a chronic course with the phobia gradually growing worse.

Very few were aware of having been definitely or possibly exposed to anxiety-provoking dental treatment situations at onset of phobia. Only 11 (10.6 %) of the phobic subjects reported this. Of those women with a dentistry phobia of low degree, four (5.7 %) were aware of this. The corresponding prevalence in high degree phobics was seven (20.6 %).

As can be seen in Table 4 there were positive correlations between number of missing teeth, bone score and degree of

phobia. The associations were statistically tested with adjustment for age only, as well as with correction for both age and social class. A high degree of dentistry phobia was also found among removable denture wearers (Table 4).

Discussion

In most studies the terms "dental phobia", "dental fear" and "dental anxiety" are used to denote phobia of dental treatment, fear of dental treatment, etc. The latter expressions have a more precisely descriptive character and are not so loaded with symbolic overtones as "dental

Table 5
Community studies of dentistry phobia

Year	Author	Ref.	Country	Sample size	Age range	Sex	Prevalence (%)
1962	SIFO	(2)	Sweden	1331	12-75	M, F	14
1978	Håkansson	(5)	Sweden	1302	20-60	M, F	10
1982	Scott & Hirschman	(1)	U.S.A.	609	< 25	M, F	8-15
1984	Hällström & Halling		Sweden	784	38-54	F	13.4

anxiety". We therefore prefer the synonyms "dental treatment phobia" and "dentistry phobia". This phobia belongs to the monosymptomatic or simple phobias and is characterized by a persistent, irrational fear of, and compelling desire to avoid dental treatment.

Anxiety or fear of dental treatment without avoidance is very common and falls outside the commonly used diagnostic criteria for simple phobia, for example those of DSM-III (16). However, the degree of anxiety, avoidance and significant distress from the disturbance differs between individuals. Therefore, in the present study the cases of dentistry phobia have been classified into two groups with high and low grade of phobia, respectively. As can be seen in Table 2 a few phobic subjects are rated low in anxiety or avoidance. Those women with low anxiety rating have, nonetheless, a high avoidance rating and those phobics with low avoidance have high anxiety rating. Individuals obviously differ in their capacity for handling anxiety and fear. A few even cannot cope with low grade anxiety in other ways than with avoidance, and others sometimes find strategies that circumvent their panic, for example by using large doses of tranquilizers, or successfully demanding dental treatment under general anaesthesia.

The main strengths of the present study are that it was conducted on a represen-

tative sample of a general population of middle-aged women and that the dentistry phobia rating was based on a standardized clinical-type interview. Thus, the present findings are not readily comparable to other work on fears and phobias of dental treatment.

Earlier community studies are summarized in Table 5. The prevalence rates of dentistry phobia and severe fear of dental treatment vary between 8 and 15 % of earlier samples studied. In these, both sexes have been included. The finding in the present study of a point prevalence rate of 13.4 % women with dentistry phobia seems to be consistent with the earlier results. However, only 4.3 % of the women presented a phobia of high grade.

Awareness of a frightening experience of dentistry did not appear to be an important factor in the development of dentistry phobia, which is in accordance with the findings in one study (17) but contrary to others (7, 17, 18).

Dentistry phobia can develop at any time of life. In this study almost 90 % developed their dentistry phobia in childhood or adolescence which is in accordance with Lautch (17). When the phobia had been established, its course usually showed some periodical improvement during life. In the present study no worsening of the situation was registered.

No relationship was found between

prevalence of dentistry phobia and age, which was also reported by Wardle (8). Those women with dentistry phobia, especially the high grade phobics, had more often had lower school education and belonged to lower social classes than the rest of sample. This might be attributed to harm-avoidance and negative parental attitudes towards dentistry among those with lower education (19, 20). Women with severe dentistry phobia visited the dentist less often and if they did it was frequently due to pain. The findings seem to be consistent with the patterns observed in low income patients (21).

Impairment of dental status is related to age and low social class (22, 23) and dentistry phobia has been shown here to be associated with low social class. Therefore, in the significance testing of associations between dentistry phobia and dental status, allowance was made for age only, as well as for age and social class, in order to avoid confounding.

As expected, the higher the dentistry phobia score the higher the number of missing teeth. This can partly be explained by this category's irregular dental visits. Due to pronounced tooth loss in the severe dentistry phobia group the mean bone score total was even better here than in subjects with low grade phobia. To compensate for tooth loss, the abbreviated mean bone score was calculated for those surfaces which had the highest degree of measurability and had been longest in the dentition. However, the results from the two bone scores are mainly the same.

An association between dentistry phobia and health behaviours could not be demonstrated for toothbrushing frequency. The reports of this are probably not very reliable, however, since the responses might have been biased by the subject's perceptions of social desirability.

The results from this study clearly show that a substantial proportion of women suffer from dentistry phobia to such an extent that their dental status is impaired. Phobias of dental treatment may have serious effects on the well-being of the individual. Besides the distress from the phobia itself, the neglected dental status in a proportion of cases might implicate general health hazards. Impaired dental health in phobic subjects may also reduce their feelings of self-esteem and confidence, and thus impair their social functioning in a wide range of situations. The extent of these negative social effects is not known, but could be substantial not least when it is known that dentistry phobia is much more prevalent in the socially deprived groups with low education, low-status jobs and low earnings.

This study also indicates that, in most cases, phobia of dental treatment has a chronic course and that the incidence peak occurs early in life. It can therefore be concluded that effective measures of prevention must be directed primarily towards children and adolescents. Furthermore, the phobic patients should be regarded as risk-patients who need regular appointments for preventive measures in order to lower their proneness to dental diseases.

Acknowledgements

This study was supported by grants from the Swedish Medical Research Council 27X-4578 and the Faculty of Odontology in Malmö. The computer analyses were skilfully performed by Mrs Gunnel Persson.

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